The Institute for Water & Watersheds
Annual Technical Report
FY 2011

Introduction

At Oregon State University, over 125 faculty teach and conduct research in areas related to fresh water supply and quality. These faculty members are spread among six colleges and represent many different academic disciplines – including engineering, ecology, geosciences, social sciences, economics and the arts. OSU also hosts a vibrant Water Resource Graduate Program where students can earn specialized degrees in water resources engineering, science, and policy and management.

The IWW is the hub for this diverse water research community. It seeks to solve complex water issues by facilitating integrative water research. The IWW's functions are to:

- Assemble diverse research teams and lead interdisciplinary and transdisciplinary water research projects.
- Help policy makers and water managers collaborate with university faculty and students.
- Offer training and access to water quality and stable isotope analysis facilities through a shared laboratory called the IWW Collaboratory.
- Encourage community and collaboration among water faculty, students and water managers by sponsoring events and producing a weekly campus water newsletter.
- Assist water faculty with project development and management.

Research Program Introduction

Why Focus on Water?

Oregon's economic vitality is directly tied to water. Water is “virtually” embedded in all Oregon products, from timber and salmon to solar panels and semiconductors. But water supply and demand in the state is changing. There is now less snowpack in mountain regions and the snow is melting earlier in the spring and summer. These changes have implications for irrigation, human consumption, hydropower generation and ecosystems. Shifting population, land use patterns and environmental policies will also influence the future supply and demand for abundant clean water. And the state of Oregon continues to develop an Integrated Water Resources Strategy, one of two western states without a strategic water plan, to prepare for climate change and the wave of anticipated “climate change refugees” from drier and hotter regions of the United States.

In the academic community there is growing recognition that the solutions to future water challenges lie not within a single discipline or subject but through the connection of concepts between multiple academic fields and through successful collaboration between academics and water managers. For example, anticipating the effect of climate change on Oregon’s water resources requires not just the input of climatologists and hydrologists but also the perspective of many others from biologists and sociologists to water managers and policy experts.

Through an integrative research approach, the IWW seeks answers to questions important for Oregon, the nation and the world, such as:

- Where are climate change and human activity most likely to create conditions of water scarcity?
- Where is water scarcity most likely to exert the greatest impact on ecosystems and communities?
- What strategies would allow communities to prevent, mitigate, or adapt to scarcity most successfully?

At Oregon State University, there are over 125 faculty in six colleges who teach and conduct research in areas related to water and watersheds and bring in over $11M/year in extramural funding. The campus also hosts strong graduate degree programs in Water Resources and is located near state-of-the-art experimental watersheds and a suite of federal environmental laboratories. Below are short descriptions of some of the university's strengths in the areas of:

- water science
- water engineering
- water policy and management
- water outreach and community education

Water Science

The OSU community has one of the largest gatherings of hydrologists and ecologists in the USA. They include not only campus faculty but also courtesy faculty from the suite of federal research laboratories located adjacent to campus. This combination makes for a world-class grouping of people, mapped against one of the strongest hydrological gradients (from the super-humid Oregon Coast to arid Eastern Oregon) in

the world. The campus is known for its cross-discipline collaborations -- for example faculty from the top-ranked forestry and conservation biology programs collaborating on salmon conservation studies. Many researchers take advantage of nearby field laboratories such as the NSF Long Term Ecological Research (LTER) facilities at the HJ Andrews Experimental Forest and industry timberland instrumented watersheds in the Oregon Coast range (Hinkle Creek, Alsea and Trask).

Water Engineering

Unlike other land-grant institutions, OSU's engineering connection gives it strengths in treatment technologies for surface water, groundwater, and wastewater systems. OSU Engineering now ranks in the top 50 programs in the US. Many OSU engineers specialize in biological treatment methods and OSU hosts a Subsurface Biosphere Initiative that emphasizes interdisciplinary research on soil and groundwater microbial ecology. Many engineering faculty are also connected to the Oregon Built Environment & Sustainable Technologies Center (Oregon BEST) that connects the state's businesses with its shared network of university labs to transform green building and renewable energy research. Partnering with the OSU College of Business places a “business face” on the sustainability of engineered solutions to water problems. Before graduating, many engineering students enroll in coursework leading to a business savvy Entrepreneurship Minor.

Water Policy And Management

Addressing water resource challenges and reducing conflict in the US and abroad requires that water professionals and decision-makers receive specialized resources and skills that go beyond the traditional physical systems approach to water resources management. OSU offers a post-graduate certificate as part of their Program in Water Conflict Management and Transformation. The program leverages personnel from the top-10 nationally-ranked Geosciences Department, the top-five nationally ranked College of Forestry, as well as specialists in water policy, social science, communication, and anthropology. The “softer side” of OSU water has close links with UNESCO, the World Bank, the US Bureau of Reclamation and the US Army Corps of Engineers.

Information Transfer Program Introduction

OSU’s reputation for providing vital environmental information to students and the public is beyond reproach. A few of OSU's water-related outreach programs include:

- The Master Watershed Steward Program - An OSU Extension program offering educational sessions and materials to help watershed groups and individuals understand how their watersheds work and apply this knowledge to watershed stewardship on their own land or in their community.
- The Oregon Well Water Program - An OSU Extension program designed to help Oregonians protect the groundwater that supplies their drinking water through education.
- The Hydroville Curriculum Project - A program proving water-themed educational materials and exercises to K-12 teachers. It is operated by OSU's Environmental Health Sciences Center.
- The Oregon Explorer Program - An online digital library that provides natural resources information to decision makers through a growing series of Web portals.
- Oregon Climate Change Research Institute - A network of over 100 researchers at OSU, the University of Oregon, Portland State University, Southern Oregon University, and affiliated federal and state labs. In 2007, the Oregon state legislature created OCCRI and tasked it with: fostering climate change research among faculty of the Oregon University System (OUS); serving as a clearinghouse for climate information; and providing climate change information to the public in an easily understandable form.

For this reporting year, the IWW experimented with a new form of Information Transfer by preparing a series of "white papers" on topics which are important to Oregonians, but have not been published in academic journals.

Likewise, IWW is building upon our popular seminar series on water issues that regularly attract 50 or more students, faculty and the interested public by not only restarting our film series dedicated to water issues, but also sponsoring and assisting a new class to teach students how to make their own documentary videos.

In related activities, IWW sponsored four students to participate in the national and international conferences focusing on the renegotiation of the Columbia River Treaty. Students worked on different scenarios with students from the University of Idaho and prepared a white paper on the project, as well as a documentary video that debuted at the international conference. The student poster developed for the international conference also was awarded Best Student Poster at the Oregon Section of the American Water Resources Association conference held in Corvallis, Oregon.

IWW also remains a technical resource for the water design group associated with the multi-institutional program dedicated to sustainability - the Oregon BEST (Built Environment for Sustainable Technologies) hosted at Portland State University where the Oregon Sustainability Center is anticipated to be built in the coming years. Each year, Oregon BEST sponsors a national conference (FEST) on sustainable technologies and IWW presented new research of site characterization for assessing the feasibility of micro-hydro power generation through a poster session.

Technology Transfer

Basic Information

Title:	Technology Transfer
Project Number:	2011OR124B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	Oregon 5th
Research Category:	Climate and Hydrologic Processes
Focus Category:	Water Supply, Climatological Processes, Education
Descriptors:	
Principal Investigators:	Todd Jarvis

Publications

There are no publications.

OREGON'S WATER MARKETS

INSTITUTE FOR WATER AND WATERSHEDS AND INSTITUTE FOR NATURAL RESOURCES—APRIL, 2012

When it comes to developing, testing, and practicing solutions to environmental issues, Oregon is full of pioneers and innovators. Over the last decade Oregon has made remarkable progress using the environmental market approach to managing the quality and quantity of our water. These pages explain environmental markets, how they work, and how Oregon is using this approach to protect our fresh water.

What are Environmental Markets?

Environmental markets provide a structure to buy and sell the benefits people get from nature. Nature's benefits (also known as ecosystem services) include food, clean water, clean air, fuel, habitats for plants and animals, and beautiful landscapes for educational or spiritual enrichment - just to name a few. These markets put a value on nature's benefits and by doing so allow people to get paid for conserving or restoring these ecosystem services. The markets approach helps to establish an accounting system that rewards conservation and provides an incentive to avoid damage to the environment. Environmental markets are developing all over the country and Oregon is considered a national leader of this movement.

How do Environmental Markets Work?

Environmental markets are driven by basic economic rules of supply and demand. In a regular marketplace there are buyers and sellers and supporting roles to handle innovation, capital investment, manufacturing, marketing, accounting, packaging, etc. Environmental markets are the same; there are buyers and sellers, and a set of supporting roles to handle the unique components of trading ecosystem services.

Environmental Market Actors:

Sellers	Land owners or land managers who receive monetary compensation for protecting or restoring nature's benefits.
Buyers	Often cities, industries and developers that purchase benefits made available by sellers to offset unavoidable damage to ecosystems. Conservation groups may also be buyers using the market to achieve their conservation goals.
Regulators	Set limits on activities that can damage nature's benefits. These limits provide an incentive for buyers to look for sellers. Regulators also determine which measurements of nature's benefits are acceptable for creating ecosystem services credits that can be bought to meet environmental regulations.
Scientists	Measure the benefits people receive from nature.
Market Specialists	Serve several roles. They may translate measurements of nature's benefits into tradable units such as credits or dollars, assist sellers to enhance their land or change their practices to generate tradable credits, develop tools to monitor changes to nature's benefits over time, or track trades and market values.
Banks	Intermediaries between buyers and sellers, collecting credits from sellers and making them available for buyers.

What are Water Markets?

Water markets quantify the benefits people receive from healthy rivers, streams, lakes, ponds, wetlands, and aquifers and translate them into credits to be bought and sold. These markets deal specifically with the amount of water flowing in our waterways and the health of that water. Water markets help to balance our need to have enough water to drink, irrigate the food we eat, and maintain stream flows of appropriate amounts and temperatures to support aquatic species such as salmon. Water markets are needed because even though water has been used as an inexhaustible resource, it is actually finite. Water scarcity is becoming an issue; yet demand for water remains high. Our waterways also have a limited capacity to accept pollution without harming our fish and wildlife or damaging our drinking water.

Low Flow of the Deschutes River at Tumalo Creek (Bend, Oregon).

Photo from the Deschutes River Conservancy

Who Benefits from Water Markets?

Markets involve several participants and have the potential to deliver various economic and environmental benefits. When a water market is well designed and appropriately managed it is possible that many can benefit.

- **Cities and industry.** By participating in water markets, cities and businesses have more flexibility as they seek to meet legal obligations to limit pollution and water use. They can save money because they may be able to use cheaper solutions to reduce their environmental impact.
- **Water utilities customers.** When drinking water and wastewater utilities lower their costs to comply with environmental regulations by buying credits in a water market, they can avoid having to pass the cost of installing expensive technology upgrades to their customers.
- **Rural landowners.** When rural landowners become sellers in the water marketplace, they increase and diversify their income.
- **Fish and wildlife.** Activities that generate credits in the water marketplace often do more than conserve water and improve water quality, they can also restore important waterways and provide new or improved habitat for fish and wildlife.
- **Oregon citizens.** Markets are one approach that could help maintain nature's benefits that Oregonians rely on, direct growth and development to the most suitable locations, boost cooperation between business and environmental interests, and strengthen the economy as a new business sector develops.

Water Quantity Markets

Markets that deal in water supply (the amount of water flowing and stored in our waterways) involve selling or loaning one's right to use water to a different user. These programs strive to reduce water wasted and increase the overall amount of water in our waterways. By providing incentives for the wise use of water, water quantity markets can make an important contribution to conservation of water as well as keep adequate year-round stream flows, which are crucial for the survival of aquatic fish and wildlife.

Water Rights Trading on the Deschutes River

In Oregon, water belongs to the people and is managed by the State government. Rights to use water are assigned to individuals and organizations through permits that define how much water can be used, from which waterway it can be taken, when the water can be removed, and for what purpose. During times of water shortage conservation is paramount. Recent legislation has provisions that allow water rights holders to transfer or lease their water right to another person or organization. The water rights holder is allowed to keep the profit from these transactions.

Central Oregon depends on the Deschutes River to provide water for agriculture, drinking, fish and wildlife habitat, and a vibrant recreational community. The River faces problems. For example, with settlement and new agricultural uses in Bend, the middle section of the Deschutes ran nearly dry in the summer months starting in the early1900s. Since dam construction near Madras in the 1960s, steelhead and salmon have been unable to access certain parts of the River. A new passage system is once again allowing steelhead and salmon above these dams. The Deschutes River Conservancy works to increase the amount of water flowing in the River by providing incentives for water users to conserve and even donate their water rights back to the River. One way they do this is through the Deschutes Water Alliance Water Bank. The Bank provides the opportunity for those water rights held by irrigation districts, to be reallocated to stream flow, cities, or to new lands within the District. Use of water banking along with other restoration efforts has resulted in improved year-round flow of water in the Middle Deschutes and has discouraged competition for water and conflict over water uses on the River. The increase in flow, in combination with other restoration efforts, has also made it possible for steelhead and salmon to return to the area above the dams.

Low flow of the Deschutes River at Sawyer Park (Bend, Oregon). Photo from the Deschutes River Conservancy

Three times more water than low flow conditions at Sawyer Park (Bend, Oregon). Photo from the Deschutes River Conservancy

Water Quality Markets

Markets are also starting to be used to improve the health of water. Salmon and other wildlife depend on clean cool water to survive and we depend on clean water for drinking. Many cities and industrial activities add pollution to our waterways. Markets can help these entities meet legal requirements to reduce pollution through restoration of natural processes that help to remove the regulated pollutants. These programs can provide cost-effective means for limiting pollution while enhancing the overall health of our waterways by promoting natural processes over costly mechanical solutions.

Temperature on the Tualatin River

There are many areas in Oregon where waterways are too warm for fish. One of the causes of warming is the removal of vegetation along the edge of rivers and streams. Without shade the water is not protected from the sun and warms up. Wastewater facilities discharge treated water that is generally warmer than healthy temperatures for the river or stream. This practice is allowed within limitations, and when those limitations cannot be met facilities need to cool water to a healthy temperature for fish. Often expensive chillers are placed on the end of discharge pipes to meet these requirements.

The market approach allows facilities that discharge warm wastewater to use natural processes to cool the water. In the case of the Tualatin River, waste water facilities and water resources managers are working with non-profit organizations to restore river and stream bank vegetation to create more shade. The shade protects the water from the sun enough to cool it to safe temperatures for fish. Landowners and managers that plant a certain amount of shading vegetation generate shade credits that can be purchased by the waste water facilities.

This type of trade also creates wildlife habitat, prevents greenhouse gas emissions from chillers, and reduces costs because chillers do not need to be installed and operated. Below you can see obvious changes in shade and wildlife habitat from creek side restoration at Fanno Creek, which feeds into the Tualatin River.

May 2006 - Before

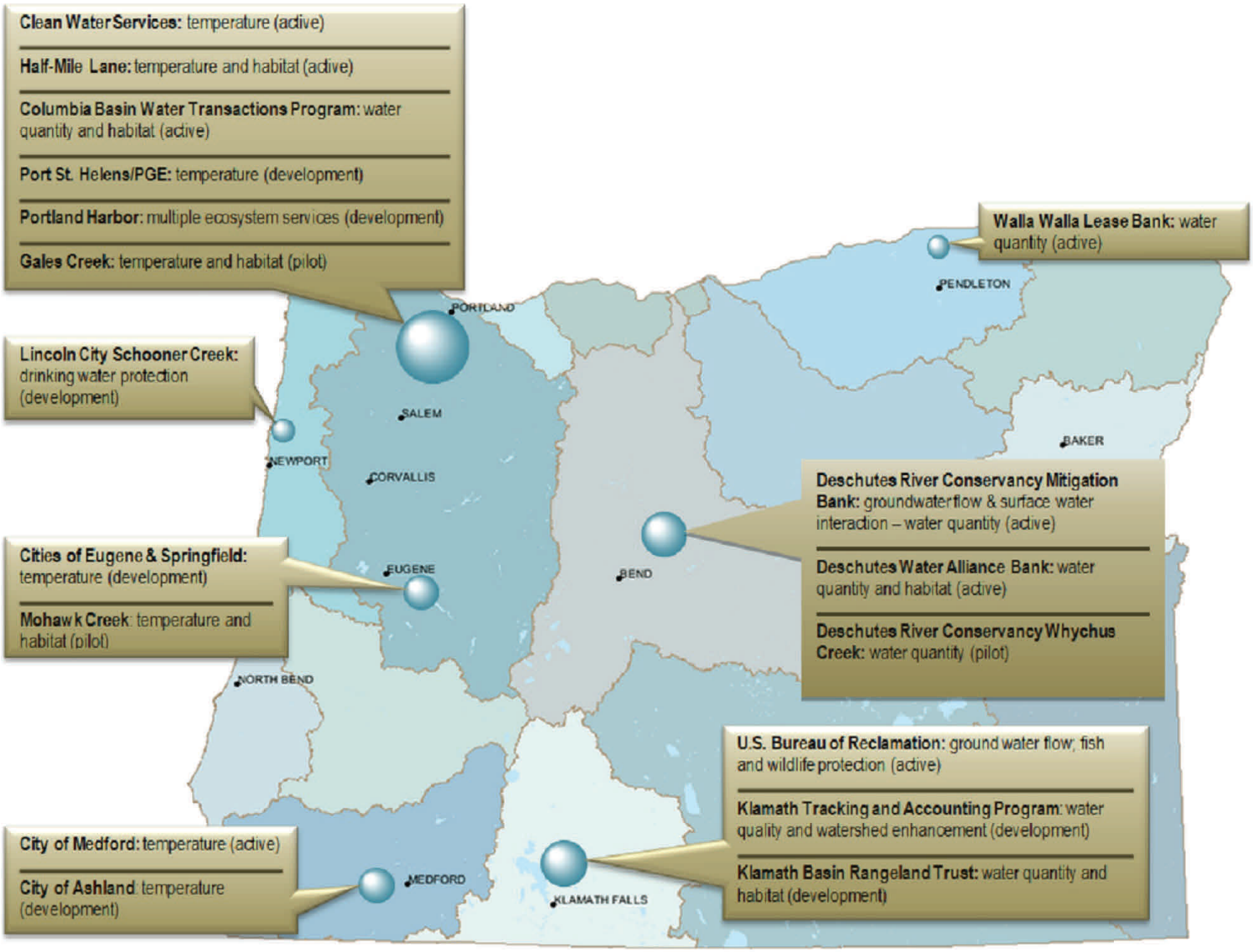
October 2006 - During

May 2011 – After

Photos from Clean Water Services

Water Markets Activity in Oregon

At the time of publication 18 water market related efforts were identified in seven regions within Oregon. Distinct efforts are identified by name and area of focus. Efforts are identified by their current phase which range from those with current or previously active trades, to those in development with permits and planning in progress, to pilot projects that tested methods then retired credits for the purpose of permanent conservation. Boundaries shown on this map indicate major basins. Many new market-based initiatives are likely to arise within the decade.



More Information

Some of the information in this paper came from the sources listed below. If you are interested in learning more about environmental markets and water markets these are great sources of information.

The Freshwater Trust	thefreshwatertrust.org
Deschutes River Conservancy	deschutesriver.org
Willamette Partnership	willamettepartnership.org
American Farmland Trust	farmland.org/environmentalmarkets
Oregon Department of Environmental Quality	oregon.gov/DEQ/WQ
Oregon Water Resources Department	oregon.gov/OWRD
U.S. Environmental Protection Agency	water.epa.gov/type/watersheds/trading
West Water Research LLC	waterexchange.com
Lotic LLC	loticwater.com
Columbia Basin Water Transactions Program	cbwtp.org
Klamath Basin Rangeland Trust	kbrt.org
Earth Economics	eartheconomics.org
Ecosystem Marketplace	ecosystemmarketplace.com
Ecosystem Economics	ecosystemeconomics.com
Ecosystem Commons	ecosystemcommons.org

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Subscribe to our weekly E-newsletter for updates on water news, events, publications, funding and job opportunities: http://water.oregonstate.edu/emaillists

OSU Oregon State University

Climate Impacts on Freshwaters: Interdisciplinary Perspectives

Spring Hydrology Seminar Series

March 30 — Niches, models, and climate change: Assessing the assumptions and uncertainties
John Wiens, Point Reyes Bird Observatory

April 6 — Water futures and the perfect storm: Implications for the Canadian prairies
Howard Wheater, University of Saskatchewan

April 13 — Unanswered questions in predicting the hydrologic impacts of climate change
Dennis Lettenmaier, University of Washington

April 20 — Streamflow, floods and climate change
Robert Hirsch, US Geological Survey

April 27 — A mechanistic framework for projecting riverine ecological responses to hydroclimatic change
LeRoy Poff, Colorado State University

May 4 — Glacier change and the future of alpine water resources
Andrew Fountain, Portland State University

May 11 — Water economics and climate change: The California experience
David Sunding, University of California—Berkeley

May 18 — Water management, knowledge and adaptation: Tensions, legacies and the next best thing
Maria Carmen Lemos, University of Michigan

May 25 — A superensemble of regional climate model futures
Philip Mote, Oregon Climate Change Research Institute

June 1 — Dooge Memorial Lecture
"How to Solve It" – A tribute to Jim Dooge, a pioneer in water systems analysis
Philip O'Kane, University College Cork, Ireland

Students can enroll for credit:
Seminar— WRS 507 (CRN 56862)
Journal Club — WRS 505 (CRN 56860;
Wednesdays, 12-12:50 p.m., Nash 104J,
FMI: Jason Dunham, jdunham@usgs.gov)

Seminar Sponsors:

- Institute for Water and Watersheds
- U.S. Geological Survey—Forest and Rangeland Ecosystem Science Center
- Water Resources Graduate Program
- Hydrologic Engineering, Inc.

WEDNESDAYS
March 30–June 1
4–5:30 p.m.
water.oregonstate.edu

ALS 4000
FREE
541-737-9918

Oregon State UNIVERSITY

Accommodations for disabilities may be made by calling 541-737-9918

Water Resources Research: At the Interface of Science and Policy

2011 Fall Water Policy Seminar WRP/CE 507 CRN 15385
Wednesdays, 4 - 5 pm, Kelley Engineering Building 1001

OSU Graduate
Water Resources Program

Applying knowledge to improve water quality
Pacific Northwest
Regional Water Program
A Partnership of USDA CSREES & Land Grant Colleges and Universities

Sept 28: Natural Resource Policy and the Oregon Legislature: Adventures Outside Academia
Racquel Rancier, Water Resource Policy and Management Program, Oregon State University

Oct 5: Incorporating Distributed Temperature Sensing into the USGS Geophysical Toolbox: Case Studies Combining Mile-Long Thermometers and X-Ray Vision (with Astigmatism)
Frederick Day-Lewis, USGS

Oct 12: Geomorphic response of rivers downstream from retreating glaciers on Mount Rainier, Washington
Chris Magirl, USGS

Oct 19: My (Soon to Be) One Year as AWRA President: Earning Premier Executive Status and Other Accomplishments
Michael Campana, Professor, Department of Geosciences, Oregon State University; President, American Water Resources Association

Oct 26: Getting a Water Plan that is Both Good and Right: The Oklahoma Experience
Will Focht, Associate Professor of Political Science, University of Oklahoma; Director, Oklahoma Water Resources Research Institute, Environmental Institute, Environmental Science Graduate Program

Nov 2: Stakeholder Learning to Action Networks: Using Collaborative Learning to Inform Models of Coupled Human-Natural Systems

Samuel Chan, OSU Sea Grant Extension and WW2100 Broader Impacts Team Lead and Mary Santelmann, SLAN member)

Nov 9: Planning with Complexity: Collaborative Rationality and Public Policy
Judith Innes, Professor, Department of City and Regional Planning, UC Berkeley

Nov 16: Blue Revolution: Unmaking Americas Water Crisis
Cynthia Barnett, senior writer at Florida Trend Magazine, author of two books, *Mirage: Florida and the Vanishing Water of the Eastern U.S.*, and *Blue Revolution: Unmaking America's Water Crisis*

Nov 30: International Transboundary Aquifers: science, policy and social issues
Alfonso Rivera, Geological Survey of Canada / Commission géologique du Canada

WRE 507 Winter Seminar Series *Winter 2012*

Water Sustainability in an Era of Change

On Wednesdays 4-5pm at ALS 4000 **CRN 37608**

January 11 : John Bolte - Biological and Ecological Engineering, Oregon State University. *Willamette Water 2100.*

January 18 : Anna Michalak - Environmental Earth System Science, Stanford University. *Mining sparse water quality data using spatial statistics.*

January 25 : Heejun Chang - Department of Geography, Portland State University. *Is water getting scarce under climate change in the Willamette River basin?*

February 1 : Anne Nolin – Geosciences, Oregon State University. *Title: Perspectives on Climate Change, Mountain Hydrology, and Water Resources in the Oregon Cascades, USA*

February 8 : Hamid Moradkhani – Civil and Environmental Engineering, Portland State University. *Understanding and Quantifying Uncertainties in Hydrologic Climate Change Impacts Studies*

February 15 : Roy Haggerty – Geosciences, Oregon State University. *Using aquifer storage and recovery for streamflow management*

February 22 : Ian Waite – Oregon Water Science Center, U.S. Geological Survey. *Application of Watershed Disturbance Models to Predict and Assess Biological Integrity of Stream Ecosystems*

February 29 : Christina Tague – Bren School of Environmental Science and Management, UC Santa Barbara. *Water and Forests: Sensitive (and not so sensitive) interactions in changing climate.*

March 7 : David Hill – Civil Engineering, Oregon State University, *Coastal freshwater discharge: how to get it and what to do with it*

March 14 : Steve Loheide – Civil and Environmental Engineering, University of Wisconsin-Madison. *Groundwater provides ecosystem services and disservices*

THE 2012 WINTER WATER FILM SERIES

INSTITUTE FOR WATER & WATERSHEDS – 2012 WINTER WATER FILM SERIES
Tuesdays, 4:00pm-5:30 pm MEMORIAL UNION – FREE SNACKS AND DRINKS

January 10 – ***Mountains In The Mist*** – Sampurno Bruijnzeel - 40 minutes – See how scientists try to unravel the secrets of amazing cloud forests, Learn how Costa Rica is working to protect forests saving the mist for future generations. ***Sponsor: INR – JPLC Journey Theater M.U.***

January 17 – ***River of Renewal*** – Jack Kohler- 55 minutes – the story of conflict over the resources of California and Oregon's Klamath Basin. Over the years, different dominant groups have extracted its minerals, trees, and water with disastrous consequences. ***Sponsor: INR – La Raza Room 208***

January 24 – ***Red Gold*** – Travis Rummel - 55 minutes –The Kvichak and The Nushagak Rivers are the two largest remaining sockeye salmon runs on the planet. Mining companies have proposed to extract the richest possible deposit of gold and copper in the world. ***Sponsor: IWW – La Raza Room 208***

January 31 –***Bull Run*** – Eric Cain - 30 minutes – The Bull Run watershed has one of the prettiest big dams in Oregon. But to protect the water from contamination, the entire area has long been closed to public access. ***Sponsor: OCCRI La Raza Room 208***

February 7 – ***Water Voices*** – 60 minutes – ***La Raza Room 208*** → Kids Night

February 14 – ***Gaslands Pt #1*** – Josh Fox – 60 minutes – A recently drilled nearby Pennsylvania town reports that residents are able to light their drinking water on fire. This is just one of the many astonishing revelations of a new country called GASLAND. ***Sponsor: IWW – La Raza Room 208***

February 21 – ***Gaslands Pt #2*** – Josh Fox – 60 minutes – ***Sponsor: IWW – APA - Room 206***

February 28 –***Water Life Pt. #1*** – 60 minutes Water's journey from streams entering Lake Superior to the mouth of the Saint Lawrence Seaway takes 350 years. The narration establishes the importance of the Great Lakes for the U.S. and Canada's fresh water. ***Sponsor: OCCRI – La Raza Room 208***

March 6 – ***Water Life Pt. #2*** – 60 minutes ***Sponsor: OCCRI – La Raza Room 208***

March 13 – ***Student Film Night*** – 60 minutes ***Sponsor: INR – La Raza Room 208***

Institute for Natural Resources

Institute for Water and Watersheds
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Oregon State University
Corvallis, OR 97331-2208
http://water.oregonstate.edu/

OCCRI

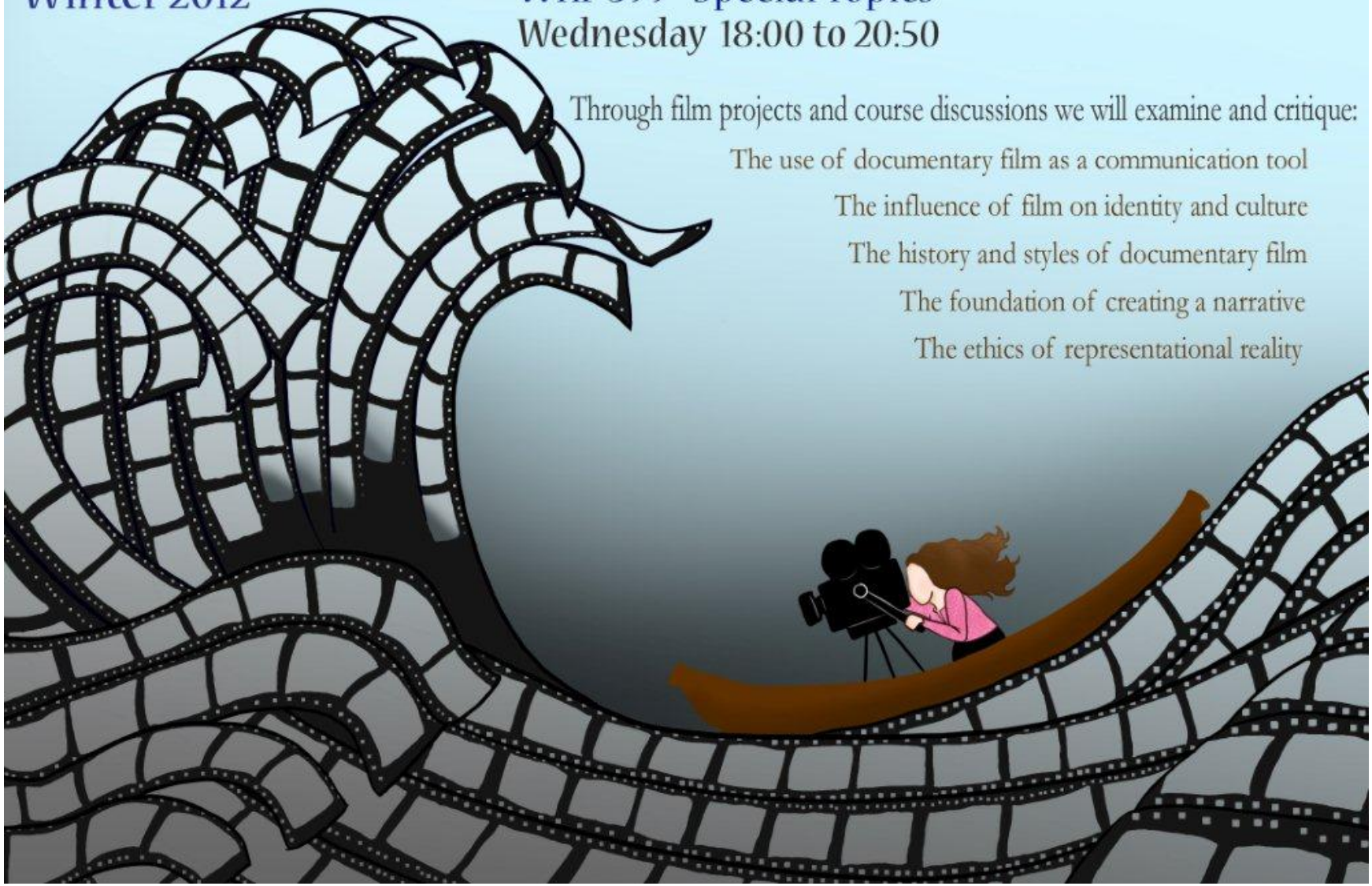
For more information please contact Justin Quinn **quinnjus@onid.orst.edu**

Documentary Film for Water Resources

Instructor: Filmmaker, Sarah Sheldrick
s.sheldrick@gmail.com

Winter 2012

WRP 599 Special Topics
Wednesday 18:00 to 20:50



Through film projects and course discussions we will examine and critique:

- The use of documentary film as a communication tool
- The influence of film on identity and culture
- The history and styles of documentary film
- The foundation of creating a narrative
- The ethics of representational reality

COMBINED REPORT ON SCENARIO DEVELOPMENT FOR THE COLUMBIA RIVER TREATY REVIEW

University of Idaho

Oregon State University

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PART I: UNIVERSITY OF IDAHO REPORT

SCENARIO DEVELOPMENT FOR THE COLUMBIA RIVER TREATY REVIEW

Barbara Cosens, Emmi Blades, Meghan Carter, Mark Cecchini Beaver, Mary Grant, Gregory Haller, Dylan Hedden-Nicely, Tyler Olson, Saundra Richartz, Nicholas Sackman
Editors: Shanna Knight, Kate Mankoff, and Allison Parker

1. INTRODUCTION

In 2024, provisions of the 1964 Treaty between the United States and Canada regarding storage operation of Canadian dams for assured flood control expire. Should either country to seek termination of the remaining treaty provisions, it must provide notice 10 years in advance. These timeframes have given rise to what is referred to as the 2014/2024 Columbia River Treaty Review. This report is the result of a project by students in the University of Idaho College of Law seminar in Law and Science to inform that process. Between February and April of 2011, students interviewed 26 people in the Columbia River Basin to identify themes for analysis of alternatives and to develop scenarios to inform a cross-border dialogue on management of the Columbia River. This work is an outgrowth of the work of the Universities Consortium on Columbia River Governance (UCCRG), composed of faculty from the Universities of British Columbia, Calgary, Washington, Montana, Idaho, and Oregon State to develop research and to bring together scholars and stakeholders for a dialogue concerning the river. Formal processes to review the 1964 Treaty are currently underway under the leadership of the Bonneville Power Administration, the U.S. Army Corps of Engineers, and B.C. Hydro. Although some technical modeling has been done jointly, the review processes are being undertaken separately on each side of the international border. Participants in symposia held by the UCCRG in 2009 and 2010 focused on review of the 1964 Columbia River Treaty and identified the need for an informal cross-border dialogue. Further research will be undertaken over the summer of 2011, and will form the basis for a cross-border dialogue at the next UCCRG symposium in October 2011.

Understanding the alternatives and scenarios requires an initial overview of the history of the Columbia River's development prior to 1964, the 1964 Treaty, and changes since 1964 that are relevant to Treaty review. This is followed by the methodology; a summary of themes identified from interview data; alternatives and scenarios developed to address the identified themes, but informed by further research; a discussion of the processes of implementation and negotiation developed from interview data; and a discussion of the research needed to inform a dialogue.

2. BACKGROUND

2.1 THE HISTORY OF RIVER DEVELOPMENT

The Columbia River Basin covers 259,500 square miles with 15% in Canada and the remainder in the United States (Barton and Ketchum 2010). Portions of six U.S. states Washington, Oregon, Idaho, Montana, Nevada, and Wyoming, and the Canadian province of British Columbia, all lie within the Columbia River basin. Although only 15% of the basin lies within

Canada, 38% of the average annual flow and 50% of the peak flow measured below the confluence with the major tributaries originates in Canada (Shurts 2011). In addition, due to later runoff from snowpack, flow originating in Canada can be 50% of the late summer flow (Hamlet 2003). This variability also translated to substantial potential to store spring floods for summer use in the eyes of early 20th century boosters and engineers seeking to meet irrigation and other water demands in summer (Hirt and Sowards 2011). Currently, storage on the river is 40% of the average annual flow and the basin relies on substantial natural storage in the form of snowpack. Predicted reduction in snowpack and variability in that reduction will require adaptation in the face of climate change.

There were no dams in 1805 when the Lewis and Clark expedition made its way down the Columbia River to Astoria. Salmon fisheries sustained the native population and falls slowed upriver migration of salmon and provided excellent fishing locations. Each year thousands of Native Americans from numerous tribes gathered at locations such as Celilo Falls (now inundated by water behind The Dalles Dam) to fish and trade (Landeen and Pinkham 2008). Competition from commercial fishing and an influx of canneries began in 1866. The U.S. Army Corps of Engineers began transforming the Columbia River for navigation with locks at the Cascades as early as 1896, with numerous dams to follow (White 1995). Most dams in the U.S. portion of the river mainstem generate hydropower and aid navigation, but do not store substantial water (Shurts 2011). Exceptions to this run-of-the-river approach. include the Grand Coulee Dam, a federal facility that was completed on the mainstem in 1942 for irrigation and permanently blocked salmon runs from reaching Canada, and the Hungry Horse Dam that was completed on a tributary, the South Fork of the Flathead, in 1953, Libby Dam completed on a tributary upstream from Canada, the Kootenai River, in 1973; and Dworshak Dam completed on a tributary, the North Fork of the Clearwater, in 1972. (Shurts 2011).

In 1948, even though the total river flow was close to average, runoff occurred rapidly and peaked with a flood in May that destroyed the town of Vanport, Oregon with estimated flow of over 1 million cubic feet per second ("cfs"), (average peak flows are less than half that rate), (Barton and Ketchum 2011). At the time of the 1948 flood, total storage capacity on the Columbia River was about 6% of the average annual flow (White 2011). Compare this to the Colorado River with a storage capacity of over 4 times its average annual flow or the Missouri River with storage capacity over 2 times its average annual flow. (Barton and Ketchum 2011) The approach to flood control at the time, implemented by the U.S. Army Corps of Engineers was storage. Problematically for the United States, the best remaining storage sites were in Canada.

Even before the 1948 flood that wiped out the town of Vanport, Oregon, the International Joint Commission formed by the 1909 Boundary Waters Treaty between the United States and Canada was directed to study the possibility of storage within Canada to provide flood control or power benefits to both countries (Mouat 2011; Shurts 2011). The Columbia River Treaty, which would form the framework for flood control and power, was not adopted until 1964. Obstacles to its completion included that the three new dams contemplated in the treaty would all be in British Columbia while the majority of the flood control and hydropower would benefit the United States (Mouat 2011; Shurts 2011), and disagreement between British Columbia and the Canadian federal government. The first turned out to be minor once it was realized that money could make

up that difference. The second was more difficult. Between 1961 and 1964, negotiations between the federal government of Canada and the province of British Columbia led to a solution that would turn the operation and benefits under the Treaty over to British Columbia and divide benefits between the U.S. and British Columbia (Mouat 2011; Shurts 2011; Hirt and Sowards 2011). The resulting solution has been held throughout the world as the pinnacle of international cooperation on non-navigational uses of freshwater sources (Barton and Ketchum 2011). The Treaty would provide for three dams to be built in Canada: Mica, Duncan, and Keenleyside; a payment of $65 million from the United States to Canada for flood control; and a 50/50 division of the benefit of the additional hydropower generated in the United States due to release from the three new dams with the Canadian share referred to as the "Canadian Entitlement." In addition, the Treaty allowed the United States to build Libby Dam on the Kootenai River, which would back water into Canada (Columbia River Treaty, Article III). Finally, the Treaty provided for appointment of operating entities by the United States and British Columbia. The U.S. selected the Administrator of the Bonneville Power Administration and Division Engineer of the Northwestern Division U.S. Army Corps of Engineers. (Exec. Order No. 11,177, 29 Fed. Reg. 13097. Sept. 16, 1964). British Columbia selected BC Hydro (Barton and Ketchum 2011).

One further complication needed to be addressed before the Treaty could be completed. In 1964 the Pacific Northwest's market for energy was less than the amount of power the new projects would generate. In addition, Premier Bennett of British Columbia sought upfront sale of energy to finance the dams. The solution came when Congress authorized construction of the Pacific Northwest-Pacific Southwest Intertie allowing sale of power to utilities in the southwestern United States, with a preference for sale to northwest utilities (Pacific Northwest Consumer Power Preference Act, 16 U.S.C. § 837. 2006), and the actual agreement for sale. Thirty-year contracts for the sale of hydropower to a consortium of utilities in the basin who then sold to the southwestern United States included payment to Canada of $254 million, an amount sufficient to cover dam construction (Shurts 2011). Although this payment was based on the estimated present value of anticipated power sales, it did not come close to the actual value that would have been realized on renewable contracts over the same 30 year period (Shurts 2011).

The Treaty contains no automatic termination date or renegotiation clause; 2024 is the earliest date either party may terminate the Treaty (Columbia River Treaty Article XIX). At least ten years notice of termination must be provided, hence the importance of a thorough review of the Treaty before the year 2014. The operating entities are studying options to be explored by 2014, and have announced that a process of stakeholder input will begin upon completion of technical studies (United States and Canadian Entities 2009). Certain flood control provisions, paid for upfront by the United States to cover sixty years, expire in 2024 (Columbia River Treaty Article IV). This expiration alone has led to consideration of Treaty modifications (Shurts 2011). The following substantial changes in the basin have also lead to this possibility.

2.2 Basin Changes Since 1964

A symposium on the Columbia River Treaty held by the University of Idaho in collaboration with other basin universities in 2009 examined change since 1964 and possible future change regarding (1) change in values concerning the river; (2) change in empowerment of local

communities and in particular, of Native American and First Nation governments; (3) change in the viability of populations of anadromous fish that spawn within the Columbia River system; (4) change in energy demand; and (5) climate change. This report will briefly summarize some of the important points raised by participants in the symposium. A more complete summary can be found in Cosens, 2010. It is important to note in considering these changes that not all are of equal importance to the two countries involved in the treaty. Addressing change at the appropriate scale, rather than folding all issues into the international treaty, will be one of the important considerations in building adaptive capacity.

Changes in societal values concerning the river are reflected in the adoption of new laws governing both the substance and process of natural resource management (Hirt and Sowards 2011), and in the results of a reconnaissance level survey of stakeholders in the basin done by students at the University of Montana (McKinney et al. 2010). The post-1964 law with the largest impact on operation of Columbia River dams on the U.S. side of the border is the Endangered Species Act (ESA) adopted in 1973, which forbids federal actions that jeopardize listed species (Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544. 2006 (ESA)). Eight salmon and four steelhead species that rely on habitat within the basin are listed (NOAA 2005),[1] and two species of resident fish (U.S. Fish and Wildlife Service). Although numerous factors impact these species, operation of dams for hydropower has been identified as a major factor, and operation of the Federal Columbia River Power System (the part of the hydropower system at federal dams in the U.S. portion of the basin) has been the subject of numerous lawsuits under the ESA.[2] The ESA and subsequent listings reflect a change in values and provide a powerful lever for inclusion of issues concerning anadromous fish in any negotiation concerning operation of dams on at least the U.S. portion of the river.

Dramatic changes in the health of the Columbia River ecosystem are reflected in the declines of populations of anadromous fish that spawn within the system. The completion of Grand Coulee Dam in the 1940s blocked the natural migration of anadromous fish. Thus, the blockage of migration to Canada and the reservations of certain upper Columbia River Native American Tribes was a fait accompli by the time of the 1964 Columbia River Treaty. In the remaining portion of the basin, salmon declined from an estimated high of 6 to 16 million in the early 1880s

[1]Current listings of salmon species found in the Columbia Basin: Snake River Sockeye (endangered), Upper Willamette River Chinook (threatened), Lower Columbia River Chinook (threatened), Upper Columbia River spring-run Chinook (endangered), Snake River fall-run Chinook (threatened), Snake River spring/summer-run Chinook (threatened), Lower Columbia River Coho (threatened), Columbia River Chum (threatened). Final Listing Determinations for 16 ESUs of West Coast Salmon, 70 Fed. Reg. 37160, 37193 (June 28, 2005). Note that four ESU's of steelhead are also currently listed: 69 Fed. Reg. 33105 (June 14, 2004) and 71 Fed. Reg 5178 (Feb. 1, 2006). However, these listings are currently in litigation. *See e.g.,* Trout Unlimited v. Lohn, No. CV06-0483-JCC 2007 WL 1795036 (W.D. Wash. Jun 13, 2007), *aff'd in part, rev'd in part* 559 F.3d 946 (9th Cir. 2009); *see also* NOAA, Northwest Regional Office, ESA Salmon Listings, Salmon Populations, http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Index.cfm (last visited Apr. 5, 2010)

[2] *See, e.g.,* the many challenges to Biological Opinions issued by NOAA Fisheries (formerly National Marine Fisheries Service – NMFS) in 1993, 1995, 2000, and 2004: Idaho Dept. Fish and Game v. NMFS, 850 F. Supp. 886 (D. Or. Mar. 28, 1994); American Rivers v. National Marine Fisheries Service, CV 96-384-MA,1997 WL 33797790 (D. Or. Apr. 3, 1997); National Wildlife Federation v. National Marine Fisheries Service, 254 F. Supp. 2d 1196 (D. Or. 2003); National Wildlife Fund v. National Marine Fisheries Service CV 01-640-RE, 2005 WL 1278878 (D. Or. Oct. 7, 2005); National Wildlife Federation v. National Marine Fisheries Service, 422 F.3d 782 (9th Cir. 2005); National Wildlife Foundation v. National Marine Fisheries Service, CV 01-640 RE, 2005 WL 2488447 (D. OR.); NWF v. NMFS, 524 F.3d 917 (9th Cir. 2008).

to less than 1 million non-hatchery fish today (Peery 2011). The salmon fishery in the Columbia River basin is now supported by approximately 200 hatcheries (Peery 2011). It is difficult to argue that these changes were not foreseen (Bottom et al. 2009), but regardless, hatcheries remain controversial.

In 2009 a special edition of Ecology and Society explored the prospects for Pacific salmon, including Columbia River populations (Bottom et al. 2009; Healey 2009; Waples 2009), Consider how, in contrast to the single population of Atlantic salmon, Pacific salmon have adapted to the relatively dynamic geologic coastline and riverine environment of the west coast of North America through the development of multiple locally adapted populations (Waples 2009). The 10 million year survival of Pacific salmon in the face of a highly dynamic coastal environment is a tribute to their resilience (Healey 2009). However, anthropogenic changes have occurred on both a scale and timeframe that do not match historic geologic variability in the system (Healey 2009). Thus, the key to restoring salmon resilience is not merely maintaining genetic diversity through hatcheries, but also re-establishing the natural processes that led to adaptation (Healey 2009). Because salmon require the entire length of a river system as well as the ocean to complete their life cycle, this would require a daunting level of cross-jurisdictional coordination (Bottom et al. 2009). Importantly, at the 2009 UCCRG Symposium, a caution was raised that "'[i]t is uncertain whether degraded salmon ecosystems remain sufficiently resilient to respond positively to ongoing restoration programs, or have shifted to a stable, low-productivity state that may persist regardless of the climatic regime'" (Leschine 2009). Resilience is "[t]he amount of disturbance an *ecosystem* can accommodate without shifting to a fundamentally different structure, function and feedback mechanisms . . ." (Bottom et al. 2009) It is possible that the ecological system of the Columbia River has been altered to the point that salmon restoration in any way resembling a natural system is impossible.

Additionally, the blockage of anadromous fish from Canada has led some to argue that restoration is purely a domestic U.S. issue. Many feel that no incentive exists for Canada to consider operation of treaty dams to enhance salmon migration. This may be an area in which addressing the biological issue on the U.S. side while seekingapproaches to shared benefits at the basin scale might be used to move toward greater ecological resilience (with the caveat that it may be impossible to ever return to a natural, rather than an engineered, salmon population in a human timeframe).

In addition to changes in ecosystem health, energy demand has not increased as expected in 1964. At the time of finalization of the 1964 Treaty, planners expected the rapid growth in power demand that followed World War II to continue and that new thermal generation would replace hydropower as the dominant source of energy in the Pacific Northwest (Shurts 2011). Nation-wide conservation in the wake of the 1970s energy crisis altered this picture, and hydropower remains the dominant energy source in the region (Hirt and Sowards 2011). Correspondingly, the value of the system has grown dramatically. With the current push to develop non-carbon sources of energy, hydropower is likely to become even more valuable. The recent draft power plan released in September 2009 by the NWPCC indicates "the most cost effective and least risky resource for the region" to meet electricity demand over the next 20 years "is improved efficiency of electricity use" (Northwest Power and Conservation Council 2010). If this projection proves true, it is likely hydropower will dominate northwest energy

production through any near-term scenarios. However, many remain skeptical that the required level of conservation will ever be achieved and Phase 1 studies by the Treaty operating entities contemplate increases in reliance on thermal power in the basin. Nevertheless, hydropower will remain a key component of the energy portfolio for the basin. Reliability of hydropower services from the river depends on transboundary cooperation on river operation.

Under the 1964 Treaty, a high level of cooperation and joint planning for river operation occurs among the appointed operating entities (U.S. Army Corps of Engineers and Bonneville Power Administration for the U.S., and B.C. Hydro for Canada). However, the type of agency (or "entity") level operational planning envisioned by the 1964 Treaty depends on seasonal and year-to-year variation that can be forecast within the degrees of historical variability. Six-year, one-year, and within-year planning cycles, as well as Supplemental Operating Agreements are used if mutual benefits in power, flood control, fisheries, or other values may be achieved (Barton and Ketchum 2011). In this way, the Treaty provides sufficient flexibility for adaptive management to account for seasonal and year-to-year uncertainty within the limited purposes of the Treaty. Unfortunately, climate change increases the range of variation beyond what can be predicted based on historic behavior (Hamlet 2003). Modeling by the Climate Impacts Group suggests that precipitation may not change dramatically within the Columbia River basin, albeit they also indicate that substantial uncertainty is associated with this statement (Hamlet 2003). However, changes in annual snowpack can be predicted with greater certainty and are already underway in the basin (Hamlet 2003; Nolin et al. 2011). The basin relies on snowpack as natural storage that, similar to reservoirs, moderates summer flows. With climate change, reduction in snow-water equivalent may be as much as 35% in the U.S. portion of the basin by 2060 and 12% in the Canadian portion of the basin (Hamlet 2003; Nolin et al. 2010). This reduction in natural storage means that the artificial storage configuration in the basin will be insufficient to reap the power benefits available in the past (Hamlet 2003). In particular, summer production which serves utilities in the southwestern United States might decrease if the current operation is maintained (Hamlet 2003).

A future water supply that is outside the historic water supply regime has impacts beyond power production. While the Columbia River Treaty provides an excellent framework for addressing high flow, it does not address low flow under a climate change scenario (Hamlet 2003). Adaptation to climate change for other uses such as irrigation and fisheries requires response by multiple agencies in the U.S., which currently has no framework for coordination (Hamlet 2003). Irrigation occurs during the summer season when the lowest flows will occur if storage is insufficient. A failure to address low flows will force fish and farmers to bear the brunt of climate change if no effort is made to adapt (Hamlet 2003).

A more subtle yet pervasive change in the legal governing process stems from the now global demand for greater public access to information and public participation in governmental decision making. In the United States, the indications of this trend began with the passage of the Freedom of Information Act in 1966 (5 U.S.C. §552. 2006), and the National Environmental Policy Act in 1970 (National Environmental Policy Act of 1969, Pub. L. No. 91-190, 83 Stat. 852. 1970 current version at 42 U.S.C. § 4321. 2006; Hirt and Sowards 2011). This trend is also reflected in the European Union Water Framework Directive, (European Union Council Directive 2000/60/EC, 2000 O.J. (L. 327) 1-73 (EC) the adoption of NEPA-like requirement in

over 80 countries (Percival et al. 2003), and the inclusion of public involvement requirements for water development projects funded by the World Bank. Whereas state-to-state negotiation of the international treaty in 1964 proceeded with relatively little non-federal input in the United States, and only provincial and federal level input in Canada, the rise in expectations for more robust forms of deliberative democracy will require changes in that approach in any new negotiation or domestic change. Design of a meaningful process for public input on the scale of a basin the size of the Columbia will require a new approach that proceeds at multiple scales over a number of years leading up to negotiation. The increased regional and local capacity in the basin may provide the avenues for this input as described below.

A reconnaissance-level situation assessment of stakeholders in the Columbia River basin done by students at the University of Montana under the direction of consortium member Dr. Matthew McKinney confirmed this public expectation of input within the basin, and identified two key perceptions (McKinney et al. 2010). First, if measured by the 1964 goal of flood protection and increased power production, the Columbia River Treaty has been an outstanding success (McKinney et al. 2010). Second, among the key issues identified by stakeholders that were not addressed in 1964, but should be in the future, the health of the salmon fishery, and participation by affected communities, Native American Tribes and First Nations, stood out as themes repeated by many interviewees (McKinney et al. 2010). This perception is paralleled by the dramatic change in empowerment among basin communities.

The following factors, detailed in Cosens 2010, have increased empowerment of local communities and, in particular, of Native American and First Nation governments, resulting in enhanced capacity to participate in Columbia River decision making: (1) legal recognition of the treaty rights of certain Native American Tribes to participate in the harvest and management of Columbia basin fisheries within the United States, now organized as the Columbia River Intertribal Fish Commission (CRITFC); (2) recognition of the upper basin tribes within the United States whose land was blocked from anadromous fish migration by Grand Coulee Dam, organized as the Upper Columbia United Tribes (UCUT); (3) active participation in the current treaty review by the Upper Snake River Tribes and the Confederated Salish and Kootenai; (4) establishment of the Northwest Power and Conservation Council in the United States in 1980, composed of state representatives in the United States portion of the basin and charged with energy and fisheries restoration planning; (5) constitutional recognition of the rights of First Nations in Canada in 1982; and (6) legislative recognition of the Columbia Basin Trust in Canada in 1995, formed initially as a grassroots effort to assert the rights of local communities and First Nations whose lands were flooded by Treaty dams. Many of these groups advocate restoration of the health of anadromous fish runs in the basin. These changes parallel the growing call for public participation in resource management decisions and the need for local capacity building to make this input a reality and provide the base from which public processes can be built.

3. METHODOLOGY

The UCCRG concluded that prior to the third Columbia Symposium, the range of issues people seek to discuss should be investigated and supplemented with more information to allow a robust discussion of alternatives. In addition, for the basin to move toward a more resilient social-

ecological system, each alternative needs to be viewed in light of the range of uncertainty associated with its key drivers. The following sections set forth the interview methodology used to identify alternatives and the scenario development process used to couch those alternatives in light of their associated uncertainties.

3.1 INTERVIEW PROCESS

The class identified two core questions to facilitate a cross-border dialogue.

1. What alternatives do stakeholders in the Columbia River Basin want analyzed and discussed prior to any decision on the international treaty?
2. What existing information and new research is required to inform a dialogue concerning alternatives raised in response to the first question?

To identify the range of alternatives that treaty stakeholders seek to have analyzed, this research uses a qualitative approach. A qualitative approach bases research on individual experience and attempts to understand human behavior (Schwandt 2001). Qualitative inquiry uses methods such as open-ended interviews to gather information (Creswell 2003). The focus of the research is to obtain as broad a range of alternatives as possible, rather than attempt to quantify the level of support for a particular alternative. Thus, the class considered open-ended, confidential interviews as the best approach.

A group of students in the Spring 2011, University of Idaho College of Law, Law and Science class conducted interviews with a limited set of stakeholders. These interviews have included agency representatives, tribal representatives, and other stakeholders on both sides of the international border. University of Idaho Institutional Review Board for research on human subjects approval was obtained and is attached as Appendix A. A list of interviewees is attached as Appendix B. Most interviews were conducted over the telephone. Confidentiality regarding information obtained is key to an effective interview process in order to provide a venue for stakeholders to express their concerns about the situation as well as to express possible solutions (Higgins 2006, 3), thus interview results will not be attributed to individual interviewees in this report. Again, the purpose of the research is to develop alternatives, not to identify the positions of particular interest groups.

Students used a snowball sampling method where interviewees were asked to recommend others who should be interviewed (Susskind 1999). Ideally, interviews end when either no new information is being obtained or no new interviewees are identified. In this case interviews ended due to the time constraints of a semester course; however, recommendations for additional interviews are included in Appendix C.

In preparation for the interviews, students compiled a list of questions and received comments from several key players in the basin to refine the questions shown in Appendix D. The qualitative methodology allows tailoring of questions to the particular interviewee and adjustment to address specific issues raised. However, the same basic script was used to ask the core questions.

Students then analyzed the data collected from the interviews. The results were first organized then categorized through a coding process which process breaks data into related themes for naming and identification (Creswell 2003). Coding requires examining the underlying meanings of the data instead of focusing on the substance of the data, thus enabling development of categories and subcategories, or major themes and minor themes (Susskind 1999). The interviews were then be organized according to these themes. To re-emphasize: confidentiality is the primary ethical issue in this research project. The participants' statements will be reported without attribution to any individual or group. In addition, prior to release, a draft of the report was sent to each interviewee to ensure that it reflects their opinions without breaching their confidentiality.

After developing connections between the themes, the resulting framework was used to develop alternatives and scenarios (The Susskind 1999). The class organized interview data in collective workshop-style sessions. The basic listing of themes is shown in Appendix E. The final step was to formulate alternatives and scenarios and identify areas for additional research to inform a dialogue. Alternatives for modeling and comparison were developed in areas where a wide variety of views on the ultimate goals for the basin were obtained. This is primarily evident in the area of ecosystem function. Scenarios planning, as described below, was used for each area with a common vision, and discussed briefly in the section on ecosystem planning to reflect decisions that would provide the greatest opportunity to achieve any of the visions expressed.

The alternatives and scenarios developed in this report should be considered a starting point for analysis, comparison, and an informed cross-border dialogue, but should be added to and modified as that process goes forward. We recommend that the October 2011, UCCRG Columbia River Symposium use these alternatives and scenarios as a starting point for discussion in break-out sessions with a goal of further refinement and identification of information needed to choose among alternatives.

3.2 Scenario Development Process

In contrast to the identification of alternatives for purposes of research, modeling and informing a dialogue, scenario planning is a process of using that information to identify one or more possible visions for the basin, then "backcasting" to evaluate decisions that must be made now to achieve that vision. Scenario planning is used when there is a high level of irreducible uncertainty regarding key variables that control outcomes. It has been used for years in business planning (Schwartz 1996), more recently in climate adaptation planning (Hamlet 2003), and has been suggested as a tool of watershed planning in the face of climate change (Arnold 2010). This is also the approach for power planning used by the Northwest Power and Conservation Council. The primary goal of scenario planning is to aid decision-making when forecasting is not possible (Schwartz 1996). Scenario planning sets up a process designed for adaptation from the beginning. For example, if we cannot predict changes in energy demand with accuracy for more than 20 years, what decisions must be made now and what process must be in place to allow the basin to respond to a range of possible future energy demands? If we can only predict the affects of climate change on the hydrograph within a broad range, what decisions must be made now and what process must be in place to allow the basin to respond to a range of possible future water supplies and runoff timing? In contrast, current planning under the 1964 Columbia River Treaty described above is highly constrained within the range of historic water supply,

energy demand and technology, and runoff timing. Current planning is based on forecasting from a known point rather than backcasting from a desired goal.

Scenario planning for this project involved the following steps modified from Schwartz (1996):

1. Identification of goals associated with the primary themes developed from interview coding;
2. Identification of the key driving forces associated with each theme;
3. Selection of key driving forces with high and irreducible levels of uncertainty over the next century (a timeframe chosen to reflect a slightly longer period than the 60 years before changes occur with the 1964 treaty);
4. Identification of the possible range in uncertainty of the selected driving forces;
5. Development of a scenario or scenarios that would place the basin in the best position to adapt given the range of uncertainty.

As described in the final sections, research required to allow stakeholders to compare costs and outcomes of various alternatives, further refinement of the scenarios is recommended through additional research to inform the last three steps in the process. We consider the scenarios developed more useful as an example of the scenario development process and its value in framing decision-making when faced with high levels of irreducible uncertainty. We recommend that the October 2011, UCCRG Columbia Symposium use the scenario development process to that end with the scenario developed here as merely an example or starting point.

4. INTERVIEW RESULTS

Interview results were coded by theme, resulting in five categories: power; flood control, ecosystem, implementation, and miscellaneous. Each response was then further subcategorized as a general statement regarding the specific theme, or a statement regarding a tradeoff, concern, and/or benefit regarding the specific theme. Below are summaries of the general findings by theme. Listing of themes from coding of interview results can be found in Appendix E.

In discussing general conclusions regarding the results of the interviews, possible sources of bias should be mentioned. These interviews were conducted in compliance with the methodology set forth above, by individuals performing their first project of this nature. Sources of possible bias include, but are not limited to, lack of experience of the interviewers, and the preferences, attitudes, and biases of the individual interviewer, which may be more prevalent because of the qualitative interview process chosen.

The following sections provide a brief summary of interview responses under each identified theme. A more detailed list of responses can be found in Appendix E.

4.1 POWER THEMES

Interviewees generally believe that continued hydroelectric power generation in the basin is important. They did, however, express a variety of views on its degree of importance. Some thought current reservoir operations should be maintained or enhanced to ensure maximum power return, while others regarded power generation as the second most important benefit of

coordinated river operation behind flood control. Some interviewees express that power is important, but that emphasis on power has resulted in a narrow focus for river operation. The interviewees who placed the least emphasis on the importance of power regarded it as a secondary benefit to that of the natural ecosystem. Some interviewees felt that analysis of whether to continue joint power production under the treaty should be based, by each country, on a cost/benefit analysis using reasonable assumptions on how the other country might operate without the Treaty. Others felt that the value of redundancy created by joint operation and an interconnected North American grid, along with the value to United States – Canada relations, should outweigh any cost benefit to either country created by Treaty termination.

4.2 Flood Control Themes

The diversity of interviewee's statements regarding flood control was limited; the responses fell into one of two categories. The first regarded flood control as the most important benefit provided by coordinated river operation and emphasized the necessity of maintaining it at its current level. The second category emphasized lessening our current level of reliance on storage behind dams for flood control, either because the need may be lessened by climate change or to allow more water for other uses such as ecosystem services. In either case, interviewees generally seek to prevent loss of like or economic harm from flooding.

4.3 Ecosystem Themes

The responses related to ecosystem themes were consistent in expressing a desire to elevate consideration of ecosystem function in basin management. The general sentiment expressed is that managing the river to protect, maintain, and improve the basin's ecosystem should be elevated in importance to reflect changes in social values since the signing of the 1964 Treaty. Many felt that U.S. and Canadian cultures now place greater value on natural resources. These interviewees believe the treaty should be updated to reflect this change. The most common response was that there should be a more balanced management of the river with ecosystem function as part of the balance.

However, the wide variance in how interviewees define improved ecosystem function requires that several alternatives be explored under this theme. The main difference in response was the degree of emphasis on anadromous fish and their importance to the region. Views in Canada ranged from a desire to restore anadromous fish runs in the Canadian portion of the basin, to maintaining lake levels and resident fisheries in Canada. Those in the United States seeking ecosystem restoration generally advocated altering river operation to mimic the natural hydrograph.

4.4 Treaty Review and Implementation Themes

Interviewees' comments regarding implementation were more diverse than the previous three themes. Threshold issues addressed by some interviewees included that the fundamentals of the treaty need to remain in place. Others felt that the primary question for both sides is whether there is still a need for cooperation.

The comments were coded by two statements. First, at what level do changes in agreements need to be made to achieve the goals people seek from river operation and second, who should be involved in negotiating and implementing the treaty? On the question of agreement level, some felt strongly about keeping any changes below the level requiring international negotiation and involvement by the U.S. State Department and the Canadian Foreign Ministry. The overarching goal of those with this view was to keep decision-making in the basin. To this end, interviewees suggested the use of operating and other ancillary agreements to accomplish goals without altering the underlying Treaty. At the other end of the spectrum, those seeking changes in purpose or the process for implementation of the international Treaty felt that those changes could only be accomplished through a new treaty.

Some interviewees believed that both the process of negotiation and the process of treaty implementation require broader participation. Groups often discussed as to whether they should have a greater role regarding the treaty negotiation: those groups being the Native American Tribes in the United States; First Nations in Canada; the states; and the general public. Interviewees who commented on whether the Tribes and First Nations should have a greater role all agreed they should, but did not necessarily agree on scope of that role. In addition, the interviewees were divided on whether the public should be more or less involved. On treaty implementation, some suggested that authority for governance and implementation of the river be handed over to a supranational organization.

Because the process of review and implementation are relevant to every decision made concerning the treaty and, in part, depend on the substantive issues addressed, a more detailed analysis of comments is provided following the sections on scenarios.

4.5 Miscellaneous Themes

There is no common theme to the statements in this category other than they did not fit well in one of the other four categories. There were a number of notable statements in this category. First, education about the Treaty and the benefits that the river provides is very important. Second, to some, the most important benefit the Treaty provides is predictability and stability on how each country will operate the river. Third, there are significant benefits to cooperation by the two nations beyond the Treaty, including interconnection of North American electric transmission. Fourth, restitution is still needed for indigenous people who have lost cultural resources due to development and operation under the 1964 treaty.

In addition, interviewees identified areas in which information on impacts will be necessary to inform a dialogue on management options for the river. These are areas where international operation may cause an impact to a particular use of the river, but those commenting did not believe that the use itself should be addressed at the international level. These include water quality, navigation, water diversions, and recreation.

5. Scenarios

Scenario development focused on the three theme areas of power supply, flood control and ecosystem function. To facilitate a cross-border dialogue, scenarios are used to look at the

benefits people seek from the basin as if no border exits. Whether international action is necessary to achieve those goals is a separate question discussed below in a section on negotiation and implementation. The purpose of this separation is to allow a broader dialogue on what benefits might be possible in the basin. Interviews reveled that some people would start the analysis with the question of how much can be accomplished without international action. This appeared, in part, to a perception that international action will impair regional control. As will be discussed below, this is not necessarily a correct assumption. More importantly, as academics, our role is to facilitate a broad dialogue beyond perceived constraints, recognizing that in the end, those perceived constraints may control.

The class used the scenario development methodology set forth above, interview data for theme identification, and both interview data and its own research on sources of uncertainty to develop at least one scenario under each theme. As noted above, the interview response on ecosystem function reflects a variety of goals that are not necessarily compatible. Thus the ecosystem function section begins with a discussion of alternatives for evaluation followed by a scenario that might allow the basin the most options. Research needs associated with each scenario are discussed briefly with each section. However, research needed on both the associated uncertainties and on methods, including models, for analysis and comparison of various scenarios that is applicable to all scenarios is discussed more fully in a later section. This preliminary work can be used as a starting point for discussion when the UCCRG convenes the next symposium for a cross-border dialogue on the Columbia River treaty in October 2011. However, the additional research and evaluation methodology will need to be developed to allow the basin to engage in a fully informed dialogue on options for the future

5.1 Power Supply Maintenance Scenario

Maintenance of hydropower production at or above the current level is the identified theme for this scenario. The following paragraphs discuss the various driving forces affecting the system's ability to continue producing power at current levels, highlighting areas of uncertainty. Diversifying the power supply is presented as a means to buffer against any changes in ability to produce hydropower. Whether this effort requires joint U.S.—Canada operation is a separate question discussed below in the section on negotiation and implementation.

5.1.1 Driving Forces and Uncertainty

Key driving factors associated with hydropower production include power demand; renewable portfolio requirements; technology innovation; aging infrastructure; and water supply.

Power demand is affected by a number of factors. Overall power demand will be affected by any changes in power usage due to conservation, technology changes, business and industry movement into or out of the region, population changes, and demand for energy in areas outside the basin connected through transmission. Projections of these changes have been made by NWPCC (Northwest Power and Conservation Council 2010) for a 20-year period and will be helpful in making any decisions concerning the Columbia River Treaty and power production. However, the greater the term of any new treaty, the greater the uncertainty in projections.

Both technology and political decision-making affect renewable power portfolio standards set at the state level. Hydropower is not classified as a renewable source of energy for purposes of portfolio standards. States are increasingly using renewable portfolio standards to push development of renewable energy source. Washington, Oregon, and Montana along with 21 other states currently have renewable energy portfolio standards (U.S. Dept. of Energy 2009). The amount of renewable energy required in these portfolio standards will likely increase in the future but remains uncertain. Currently in the basin, wind power is the most rapidly growing source of renewable energy. Variability in wind speed imposes a certain degree of unreliability requiring both redundancy and maintenance of hydropower as the base power source. Only if the basin turns to a thermal source such as nuclear as its primary supply will the value of hydropower diminish.

Technology innovation will also affect the ability of the Columbia River Basin to maintain production of current power levels. Currently there is no effective large-scale means to store produced energy (as opposed to water stored prior to production), so it must be manufactured when there is both demand and water supply. To even out the hydrograph for accommodation of summer demand, water must be stored behind dams. However, if an effective storage mechanism for produced energy were developed, the need to operate dams to maximize power production when needed would be reduced. Utility scale storage of power would free up river operation to meet the needs of other identified themes. Because the availability of this type of innovation cannot be predicted it will be identified as one of the high level sources of uncertainty. The function of scenario planning will then be to develop approaches that will position the basin to be sufficiently adaptable to take advantage of the technology opportunity should it arise.

Infrastructure will also affect the ability of the system to maintain power production levels in several ways. First, dams in the Columbia River system are aging. Aging dams and other aspects of power infrastructure can affect the ability to efficiently produce power. As a result, the ability to maintain and upgrade the system is a key factor to consider when evaluating the ability to maintain current power levels. Second, current infrastructure affects how non-hydropower renewables can be integrated into the system. Some of the best places to produce solar and wind power are not near current transmission lines. New transmission infrastructure requires capital expenditures and raises environmental concerns, which both present a degree of uncertainty.

Water supply and timing affect the ability to maintain current hydropower production. There are two factors that could change the timing and amount of water available, therefore affecting the system's ability to continue producing power at current levels. The first the legal requirements that affect flow timing. Endangered Species Act litigation concerning species within the river system could potentially force the river to be operated differently. This could mean spilling or holding water in reservoirs when it would normally be run through turbines for power production. The second factor is the effect of climate change on timing of water availability. As noted above, climate change predictions for the basin suggest reduced snowpack, which currently serves as natural storage. Total precipitation may not change, but instead will enter the system as rain, altering high flow times. This shift in the hydrograph will affect when and how water is stored, potentially affecting the amount of water available for power production.

5.1.2 SCENARIO

Adaptability in the face of the many forces that could affect the ability of the system to maintain current power levels requires both diversification and redundancy. The basin could explore a range of options for increasing non-hydropower renewable energy, thermal power including nuclear power, and how best to integrate these sources into the power supply system to make it more resilient and flexible. In addition, the redundancy and diversification provided by maintaining a North American grid (as opposed to separate domestic transmission) should be evaluated as one of the benefits of continued United States – Canada cooperation under an international treaty. Most importantly, the process for decision-making on hydropower operation must be sufficiently flexible to respond to surprises. Some of the governance mechanisms suggested by interviewees to increase flexibility are discussed under implementation.

5.1.3 RESEARCH NEEDED

The primary research need is rigorous cost/benefit analysis of various alternatives for river operation including (1) the range of power operation that might occur with expiration of the assured flood control and treaty termination alternatives; (2) #1 with an overlay of operation for fish flows; (3) #1 with an overlay of climate change; and (4) the range of power operation that might occur under the various scenarios and alternatives outlined below. Although there is considerable uncertainty in future power prices, these estimates can be done for the purpose of comparing relative impacts at any reasonable estimated power price. Reasonable estimates can be taken from the experience of contract negotiations when the 30-year contracts for sale expired. At that time BC BPA negotiated an MOU to sell all of that power forward on a long term basis at about $35/MWh. However, BPA refused to sign the final agreement. Price then rose to $500/MWh but more recently has fallen to about $30/MWh. Reasonable projections of where prices might go over the next 60 years should be used as long as the caveot that these numbers are useful primarily for comparative purposes is included.

To reduce uncertainty where possible, additional research that should be conducted to provide a fuller picture of the capabilities of the river system as well as possible incorporation of other renewable resources. A range of 100-year power demand projections should be developed and the current infrastructure should be evaluated to determine capacity as well as the ability of dams to continue operations at current levels as they age. The cost and ability to incorporate new renewable energy sources into the system needs to be determined in order to produce an incorporation time schedule. Each option should be overlain with climate change scenarios to ascertain potential changes in the hydrograph, which will affect power production capabilities. As discussed below, review of governance mechanisms compatible with decision-making in the face of uncertainty is needed.

5.2 FLOOD CONTROL SCENARIO

The Columbia River Treaty (Treaty) indicates that in 2024, pre-determined annual flood control operations will automatically change to only “called upon” flood control (Columbia River Treaty Article IV(3)). This automatic change concerns many people interested in the Columbia River Basin because the meaning of “called upon” flood control is not entirely clear. It has never been

used in practice and there are significant and unresolved ambiguities with respect to implementation (United States and Canadian Entities 2009). The ambiguities relate to language in the Treaty relating to expiration of the assured flood control provisions that (1) retains the ability of the United States to call upon Canada for storage for flood control when needed (Article IV(3); (2) fails to indicate whether this "called upon" storage is governed by the same provisions that apply to called upon flood control prior to the expiration which requires the use of "all related storage" in the United States prior to exercising the call (Article IV(2)(b) and Columbia River Treaty Annex to Exchange of Notes 1964); and (3) if post-2024 called upon flood control is the same as pre-2024, what is meant by "all related storage."

Specifically, the ambiguity revolves around differing interpretations among interested parties in the United States and Canada as to what "*all related storage*" means. This ambiguity was not resolved in the Phase I Report conducted by the Canadian and United States entities in July 2010 to evaluate the effect of three possible alternatives on power and flood control post-2024: 1) the treaty is terminated; 2) the treaty continues with "called upon" flood control; or 3) the treaty continues with pre-2024 flood control operations in place (U.S. Army Corp of Engineers, et al. 2009).

In addition, the level of flood protection required by the Treaty is ambiguous. The Phase I Report analyzes both views and simply notes that in light of the differing views between the Entities, "two different flow objectives were simulated," namely flooding measured by flow at The Dalles, Oregon at 450 kcfs, the flow where flooding begins, and at 600 kcfs, the flow where major damage begins, to "provide information regarding a potential range of future operations" (U.S. Army Corp of Engineers, et al. 2009). A similar statement was made in the Supplemental Report done by the U.S. Entity "to provide the results of additional studies (Supplemental Studies) conducted by the U.S. Entity in which Endangered Species Act (ESA) Biological Opinions (BiOp) and other fish operations were added to the Phase 1 studies" (United States Entity 2010).

Despite our separation of scenarios by theme, it will be important to compare the impact of various means to meet flood control on other theme areas. For example, the Supplemental Report "indicated that Called Upon flood control operations limited the ability to meet fish objectives in the U.S" (United States Entity 2010). Further, "the inclusion of fish operations reduced the U.S. system generation by about 1520 to 1665 annual average megawatts (aMW) . . . with or without the Treaty continuing and was the largest difference when comparing the Phase 1 studies to the Supplemental studies" (United States Entity 2010). As such, these studies show that the automatic change to "called upon" flood operations will reduce the flexibility of the United States in operations to meet fish and power needs while still providing flood control. Therefore, a scenario that presents a flood control alternative to provide more flexibility is desired with an underlying theme to have no loss of life and minimum property damage due to flooding.

5.2.1 Driving Forces and Associated Uncertainty

In developing this flexible scenario, several driving forces with varying levels of related uncertainty were taken into consideration. While the following does not cover the entire list of

influential forces that will be involved in the discussion of potential flood control operations, it touches on the major drivers that must be discussed to develop a scenario for flood control that results in no loss of life and minimum property damage due to flood while providing flexibility for fish and hydropower operations: climate change, forecasting water supply to determine locations at highest risk, and the ability of the U.S. to control flood domestically. In addition, class research indicates a degree of uncertainty associated with whether Army Corps of Engineers is vulnerable to a FEMA type lawsuit. All of these driving forces have been or can be modeled with the exception of the Army Corp's vulnerability to a FEMA type lawsuit, the effect of which can only be determined through litigation. The modeling of climate change, forecasting, and the ability of the US to control flood domestically will be discussed in the final sections of this report.

With regard to climate change and forecasting, the Intergovernmental Panel on Climate Change (IPCC) has provided several Assessment Reports of the state of knowledge on climate change. The latest of which is "Climate Change 2007," the IPCC Fourth Assessment Report, and the Fifth Assessment Report is due in 2014 (Intergovernmental Panel on Climate Change 2011). The IPCC "also produces Special Reports; Methodology Reports; Technical Papers; and Supporting Material" (Intergovernmental Panel on Climate Change 2011). These Reports indicate potential changes in temperature that groups like the Climate Impacts Group (CIG), "an internationally recognized interdisciplinary research group studying the impacts of natural climate variability and global climate change," consider and impose with a focus on the Pacific Northwest to model the effect of temperature changes on the region's hydrograph (Climate Impacts Group 2011). The CIG centers its work "on the intersection of climate science and public policy/resource management" and researches "climate and climate impacts and works with planners and policy makers to apply this information to regional decision making processes" (Climate Impact Group) This information can then be used to help forecast when, how much, and where precipitation will occur. While there is some uncertainty as to the type of effect climate change will have on the hydrograph of the Columbia River Basin, it is clear from all of these studies that there will be an effect from climate change and it must be considered when planning for flood control operations.

The United State's ability to control flood domestically without Canada's help is highly uncertain. The Army Corps of Engineers is currently conducting a flood risk management assessment to determine what it means to use "all related storage" and looking at all the dams along the Columbia River system including Bureau of Reclamation dams along the Snake River to determine the storage and flood prevention capacity of reservoirs. However, the Army Corps is not currently looking at the possibility of restoring floodplains or opportunities for additional storage outside the existing Columbia River system.

Finally, only litigation will reveal the vulnerability of the Army Corps to a FEMA type lawsuit and how that will affect the conversation for flood control operations along the Columbia River. In 2004, a lawsuit was filed "against the Federal Emergency Management Agency (FEMA), the federal agency charged with administering the National Flood Insurance Program (NFIP), alleging that FEMA has violated Section 7(a)(2) of the [Endangered Species Act (ESA)]. . . by not consulting with the National Marine Fisheries Service ("NMFS") on the impacts of the National Flood Insurance Program ("NFIP") on the Puget Sound chinook salmon" *(NWF v. FEMA* 2004, 1153). The court concluded that FEMA violated ESA Section 7(a)(2) "by failing to

consult with NMFS to ensure that: (1) the regulations establishing the minimum eligibility criteria for the NFIP, (2) the mapping of the floodplains, and revisions thereof, and (3) the CRS [Community Rating System] are not likely to jeopardize the continued existence of the Puget Sound chinook salmon" *(NWF v. FEMA* 2004, 1177).. Essentially, in implementing the NFIP, FEMA provided incentive to use methods such as fill and levees to remove land from mapped floodplains, thus allowing development without consideration of the impacts of the modifications to a listed species in violation of the ESA. As a result, the court ordered FEMA to "initiate consultation with NMFS on the impacts of its implementation of the NFIP-specifically on the impacts of the minimum eligibility criteria, the mapping of the floodplains, and revisions thereof, and the CRS-on the Puget Sound chinook salmon, within 60 days" *(NWF v. FEMA* 2004, 1177). As such, on September 22, 2008, a biological opinion was submitted to FEMA prepared by the NMFS "on the effects of certain on-going elements of the [NFIP] throughout Puget Sound in Washington State" (National Marine Fisheries Service 2008).

On June 25, 2009, another ESA lawsuit was brought against FEMA, alleging that FEMA violated Section 7 of the ESA by not consulting with the NMFS "on the impacts of the NFIP in Oregon on the…fifteen salmon and steelhead listed as threatened and endangered under the ESA" (Audubon Society of Portland v. FEMA 2010). On July 9, 2010, to settle the suit, FEMA entered into an agreement with Audubon that requires "FEMA to request the initiation of formal consultation with the [NMFS] on the impacts of certain aspects the NFIP was having on ESA-listed salmon and steelhead" (Audubon Society of Portland v. FEMA 2010).

It is evident that there is increased scrutiny of federal programs that provide incentive to or focus on disconnecting the river from its floodplain. Similar to FEMA, the flood control operations of the Army Corps are federal programs and by managing dams for flood control the Army Corps, similar to FEMA, makes development in the floodplain possible. Therefore, given the presence of endangered species in the Columbia River Basin, any new efforts geared towards flood management including additional dams, new levees, permitting fill, etc. that make way for floodplain development may subject the Army Corps to FEMA type lawsuits and consultation with the NMFS.

5.2.2 SCENARIO

Given the driving forces and their related uncertainties discussed above and the desire to prevent the loss of life and to minimize property damage while providing flexibility in operations, the scenario that has the most potential is one that spreads the risk management of flooding by looking to a more diverse and basin-wide array of flood management opportunities, including storage on and off the mainstem of the Columbia River and floodplain restoration and enhancement. If opportunities to absorb flood through floodplain restoration waters are developed, more water could be held in reservoirs and the United States could operate its reservoirs less conservatively for flood control purposes with greater attention to fish, recreation, and power generation. As noted above, we recommend that this scenario be initially approached as if no international boundary exists. Thus, opportunities to spread the risk should include anaysis storage and floodplain restoration opportunities in Canada, but also include the major tributaries to the Columbia in the United States. Only after that analysis is done in a cross-border

dialogue should the analysis separately look at spreading the risk in the United States alone. This second step is part of the consideration of negotiation and implementation.

5.2.3 RESEARCH NEEDS

A tremendous amount of research is available to determine the feasibility and desirability of this flexible "spread the risk" scenario with regard to flood control, however additional research and modeling is needed. The Army Corps of Engineers Flood Risk Management assessment will likely help determine some additional storage opportunities along the Columbia River system related to reservoirs. However, these studies are not sufficient to identify opportunities off the Columbia for additional storage or opportunities to absorb some of the flood risk through floodplain restoration or enhancement. More robust floodplain mapping is necessary to help identify other opportunities to spread the flooding risk. In addition, it will be necessary to overlay climate change to forecast where, when, and how much rain will fall to allow prioritization of efforts to restore floodplains.

A secondary benefit of floodplain restoration is habitat improvement. Floodplain mapping that takes into account habitat needs would allow identification of restoration sites that optimize both flood risk management and habitat needs (Williams 2011).

A final, but very important research need, is cost/benefit. For example, to determine the feasibility of creating additional reservoir storage and non-reservoir storage through floodplain restoration, a robust cost comparison study is necessary. This study must compare the costs of simply using current reservoirs to absorb flood control risk, at both the 450 kcfs and 600 kcfs flood levels at The Dalles, to the costs of creating additional storage opportunities on and off the mainstem, which may include consideration of moving people out of and restoring the floodplains. Cost comparison for floodplain restoration should take into account avoided litigation costs for a FEMA-type lawsuit. Such comparisons are essential for an informed and meaningful conversation.

Although it is possible to develop models to examine this approach, it is difficult to quantify the affect of numerous small actions to restore floodplain to allow comparison to sole use of reservoir storage. Rather than reject the approach on that basis, it might be advisable to phase in floodplain restoration as discussed below under implementation. Using an adaptive management approach, results of restoration can be monitored and the shift from sole reliance on reservoir storage for flood control can be spread over time. It is worth emphasizing that the concept of scenario planning is to position the basin now to take advantage of future opportunities and to be able to adapt to surprises. Given the types of uncertainties described above, including the possibility of major changes in energy storage potential, floodplain restoration over a 60 year period, equivalent to the life cycle of flood control under the 1964 Treaty, could place future generations in the position to achieve more of the goals described by interviewees.

5.3 ECOSYSTEM HEALTH ALTERNATIVES AND SCENARIO

On the United States side of the Basin, the operation of the Federal Columbia River Power System (FCRPS) effects thirteen species of Columbia River Basin Salmon and steelhead listed

for protection under the Endangered Species Act (NOAA, 2008). Dams on the upper part of the mainstem in the United States block anadromous fish migration from Canada. On the Canadian side of the Columbia River Basin, three Treaty dams—Keenleyside, Duncan, and Mica—are responsible for the loss of wildlife habitat, degraded water quality in reservoirs and impacts to native fish populations. The 1964 Treaty does not include ecosystem health in its purposes. As noted above, changes in operations in the United States to satisfy the requirement of the ESA, reduce power production but do not reduce the Canadian Entitlement under the Treaty. Needs of resident fish in certain stretches have been satisfied through agreements that maintain the integrity of the 1964 Treaty (Libby Coordination Agreement 2000).

Although most interviewees expressed the desire for greater attention to ecosystem health in the basin, the vision of what "ecosystem health" means varies considerably throughout the basin. Importantly, some visions expressed may be mutually exclusive. Thus this section begins with description of the following three alternatives: (1) United States anadromous fish; (2) Canada anadromous fish restoration; and (3) maintenance of lake levels. Interviewees expressed a desire to understand the tradeoffs among these alternatives, including cost, affect on flood control and power generation, and feasibility. However, years of litigation concerning dam operation on the United States side of the basin has shown that some of these questions will not have clear answers. Discussion of alternatives will be followed by a scenario designed to both allow the basin to learn and adjust implementation over time, and again, to be in a position to take advantage of future changes.

5.3.1 United States Anadromous Fish Alternative

Generally, storage reservoirs and run-of-river dams in the Columbia Basin are operated to maximize electrical production and minimize flood risk with the awkward overlay of requirements for fish flows in each country coming through purely domestic requirements on each side of the border. Reducing the risk of flooding is accomplished by capturing the spring runoff. The stored water is then released throughout the summer (to satisfy electrical demand in California) and fall and winter (to satisfy electrical demand in the Pacific Northwest). This operational regime has resulted in a pronounced shift in the hydrograph over the year as well as in dramatic daily fluctuations in river levels to meet electrical demand.

Prior to the development of storage, the hydrograph would have been much more variable. Spring freshets historically carried heavy sediment loads, which helped create important habitat features for salmon and other species. Today, much of this sediment is trapped behind dams, thereby eliminating an important function of a natural river. The timing and magnitude of the spring freshet has been significantly altered as a result of power and flood control operations. The Army Corps of Engineers manages the river so that peak flows do not exceed 450kcfs at The Dalles, significantly less than the historic peak. As a result, both riverine and reservoir ecosystems have been negatively impacted.

Salmon, steelhead, and pacific lamprey have adapted by developing life history strategies that are intricately tied to the natural hydrograph of the Columbia Basin. Juvenile fish ride the spring freshet to the estuary. A decrease in particle travel time as a result of hydropower operations has lengthened the time it takes a smolt to arrive in the estuary; a journey that once took 3–4 weeks

now extends more than five weeks. This extended travel-time increases the risk of mortality from predation and disease. Further, the slack water reservoirs are generally warmer than the river, which can increase susceptibility to disease as well as predation, since juvenile fish can become disoriented in the slack water pools.

The presence of salmon directly and indirectly affects the functionality of terrestrial and aquatic ecosystems. Construction of redds (i.e. the nests salmon construct in gravel beds to lay eggs) promotes gravel recruitment, and may change the dimensions and stability of a streambed or channel (NRC 1996). For example, redd construction along the banks of a stream may widen the channel, which would decrease erosions and scouring during flooding, which may provide a stable environment for aquatic biota (NRC 1996). Restoring salmonid populations may be directly beneficial to other species by providing a pathway for recruitment of marine nutrients. Recruitment of marine nutrients plays an important role in estuarine food webs (Fujiwara and Highsmith 1997), freshwater and riparian vegetative growth, and growth of periphyton (NRC 1999). Avian predators, marine and terrestrial mammals, and insects may benefit from live and dead salmonids (Hewson 1995; NRC 1996). With the decline of salmon in the United States and the outright extirpation and extinction in Canada, ecosystem health basin-wide has declined as evidenced by the ESA listings.

The rate at which water releases from dams, referred to as ramping rates, also has impacts. When dams are operated to meet daily load, ramping results in dramatic changes in river elevation throughout a typical day. In the Hanford Reach and elsewhere, ramping at upstream dams causes extensive juvenile stranding and mortality when fish become trapped in pools cut-off from the river. These pools quickly percolate through the substrate or become lethally warm before they are reconnected to the river when water is again released for power. Significant mortality occurs due to excessive ramping.

The following paragraphs describe two approaches to improving flows for anadromous fish that were suggested by interviewees, along with the uncertainties and research needs associated with each.

5.3.1.1 United States Anadromous Fish Alternative Approach 1: Restoring a Natural Hydrograph

Due to the ecosystem impacts resulting from the construction and operation of the Columbia River hydro system, many interviewees expressed the desire to restore a natural hydrograph to the Columbia River. In essence, this approach requires filling reservoirs, passing the spring freshet, and drafting during the summer months to provide additional flow augmentation. Targeted flows at The Dalles would be higher than the current fish flows. Additionally, this approach requires less dramatic ramping rates of release from dams.

5.3.1.1.1 Driving Forces and Associated Uncertainty

The current health of riverine and reservoir ecosystems has been investigated extensively. However, there remains considerable debate about the nature and extent of these impacts and how changing the current operating regime may improve ecosystems.

Ocean conditions are an important component in the number of adult salmon that return to spawn. For example, the Pacific Decadal Oscillation, a driver of surface ocean temperatures, food abundance and diversity, is an important factor affecting adult salmon populations. Generally, cooler ocean conditions benefit salmon populations while warmer temperatures do not. Coastal waters off the Pacific Northwest are influenced by atmospheric conditions not only in the North Pacific, but also in equatorial waters, especially during El Nino events (Ainsworth et al. 2011). Strong El Nino events result in the transport of warm equatorial waters northward along the west coast of the United States. El Nino events have generally corresponded to decreased adult returns of salmon (Ainsworth et al. 2011). While fish tagging and counts will remain important, implementation of any changes in river operation to restore ecosystem function should include identification of in-basin variables that can be monitored to determine ecosystem health independent of ocean conditions.

Another important driver in restoring a natural hydrograph is the overall political will of the stakeholders to make sacrifices in power, flood control, and navigation to accomplish the goal. Hydropower operations that mimic a natural hydrograph will translate to higher spring peak flows, which translate into less conservative flood control operations. Additionally, spilling water over dams as a means of juvenile passage means less water going through turbines and a corresponding decrease in power production. Operating run-of-river dams at minimum operating pool may affect barge transportation.

Flow augmentation, another important component for increasing velocity and decreasing juvenile travel time to the estuary, requires that reservoirs are filled to ensure sufficient water is available to provide summer flows. Large storage reservoirs such as Grand Coulee, Dworshak, and Libby Dam can provide flow augmentation and have the added benefit (especially Dworshak) of providing cooler water (45˚ C), which reduces overall river temperatures, unnaturally elevated due the presence of the dams.

Mainstem habitat condition is a key uncertainty. Fall chinook salmon are mainstem spawners and require substrates of a certain quantity and quality. Sediments that are not replenished can disappear over time from dam operations; therefore, sediment fate and transport is an important research need.

Two areas of uncertainty exist that cannot be reduced through additional research. The outcome of ESA litigation and its affect on operation of the FCRPS can only be determined through a final court ruling. Alternatively, changes in operation and monitoring could, overtime, reduce litigation. An even greater uncertainty expressed by scientists in the basin and noted above, is whether anadromous fish are sufficiently resilient to recover even with a natural hydrograph. This can only be answered through implementation and monitoring – i.e. adaptive management.

5.3.1.1.2 RESEARCH NEEDED

Research needed to inform a dialogue on whether ecosystem function should be included in the treaty and the impact of operating the river under a more natural hydrograph include: (1) modeling the associated changes in hydropower production; (2) identifying any increased flood

risk; (3) identifying the benefits and harms on flow and lake level requirements for resident fish; and (4) identifying the benefits and harms to other fish and wildlife. Modeling should include an overlay of climate change. In addition, because current conditions prevent the migration of anadromous fish into Canada, this scenario will require investigation of means of sharing benefits with Canada either through improvements in resident and lake fisheries set forth in the third ecosystem function alternative, or through increased hydropower revenue. The following is a more complete list of research needs required to determine if a change in river operation is likely to result in improvements in anadromous fish runs. The timeframe for results on many of these mean that they would need to be incorporated in an adaptive management approach to implementation as opposed to being determined during Treaty review.

- Flood control studies
- Smolt survival at each dam under current operations
- Smolt survival at each dam based on different levels of spill
- Smolt survival at each dam based on different levels of flow augmentation
- Smolt to Adult Returns (SARs) based on current operations
- SARs based on different levels of flow augmentation
- SARs based on different levels of spill
- Forest health based on number of adult salmon returns
- Ocean conditions
- Identification of in-basin monitoring parameters that are independent of ocean conditions
- Mainstem riparian function
- Condition of estuary habitat based on altered hydrograph and condition of estuary habitat based on different flow regimes
- Reservoir health—available fish habitat, water quality, riparian habitat
- Riverine water quality
- Sediment supply, fate and transport
- Impact of commercial, Tribal, and recreational fisheries on adult returns
- Economic value of anadromous fisheries, i.e., harvestable salmon runs
- Economic value of resident fisheries
- Economic value of power/flood control equal with non-ESA listed harvestable runs of salmon

5.3.1.2 United States Anadromous Fish Alternative Approach 2: Summer Flow Augmentation

This approach is captured within the natural hydrograph scenario but is given individual treatment due to its importance for juvenile fish passage. In addition, it may require identification of different approaches to compensation for use of Canadian reservoirs, and may involve changes in summer power generation when compared to the natural hydrograph scenario.

Under this approach, dams would be operated to maximize the assurance of refill by June 30 of each year. Water would then be released in July, August and September to aid in juvenile fish passage at mainstem dams. Cooler water released during the summer aids juveniles as well as returning, pre-spawn adult fish.

5.3.1.2.1 Driving Factors and Associated Uncertainties

The ability to provide reasonable flood control while still ensuring refill is the primary driving factor of this scenario. Water supply forecasting must be improved and coordinated to increase the likelihood of success.

The majority of juvenile salmon migrate to the ocean between June and August as subyearlings. However, some fish, as a result of summer dam operations that provide cooler water, as well for other reasons, tend to overwinter in the system and migrate to the ocean as yearling fish.

Thermal impacts to juvenile and adult fish are well understood. Adults exposed to elevated temperatures can result in mortality, delayed spawning, decreased gamete viability, and reduced spawning success. Juvenile fish exposed to elevated temperatures are at risk of disease and increased mortality.

5.3.1.2.2 Research Needed

Similar to the first approach, the research needed to inform a dialogue on summer flow augmentation include: (1) modeling the associated changes in hydropower production; (2) identifying any increased flood risk; and (3) identifying the impacts on flow and lake level requirements for resident fish. Modeling should include an overlay of climate change. In addition, because current conditions prevent the migration of anadromous fish into Canada, this approach will require investigation of means of sharing benefits with Canada either through improvements in resident and lake fisheries set forth in the third ecosystem function alternative, or through increased hydropower revenue. The following is a more complete list of research needs required to determine if a change in river operation is likely to result in improvements in anadromous fish runs.

- Research needs iterated from Approach 1
- Percent of juvenile migrants that overwinter in the system and migrate as age 1 fish as opposed to those that migrate to the estuary as subyearlings
- The impact of cold water releases on migration timing.
- Mortality resulting from elevated temperatures

5.3.2 Upper Columbia Basin Anadromous Fish Restoration Alternative

Many interviewees expressed the desire to restore salmon to blocked areas within the United States (above Grand Coulee and Chief Joseph dams) as well as into Canada. First Nations in Canada and Native American Tribes in the United States have strong cultural interests in this restoration.

5.3.2.1 Driving Forces and Associated Uncertainty

The political will to restore salmon and other species to their former habitats will be a driving factor in determining whether this alternative can be implemented. Reintroduction will be costly. Additionally, if the reintroduced fish are protected under the Endangered Species Act in

the U.S. portion of the basin, many people may be resistant to this concept if it means restrictions on their businesses or livelihoods.

Reintroduction and restoration of salmon to blocked areas will be driven by the ultimate goals of those advocating for this alternative. If the goal is to establish naturally producing populations, consideration of available spawning habitat or the availability of restorable spawning habitat in blocked areas will be the key issue in determining whether this alternative can be implemented. If the goal is to establish fisheries, then habitat conditions are less of a consideration and hatchery development is more important.

Options for fish passage, both adult and juvenile, must be investigated for this alternative. Because some dams, such as Grand Coulee, are simply too tall for conventional adult fish ladders, other options, such as elevators or trap and haul techniques need to be considered at these dams for upriver fish passage. For out-migration of juvenile fish, passage may require a trap and haul scheme or there may be opportunities for in-river passage.

Additionally, the use of hatcheries is an important consideration. Reintroduction, by default, will require the use of hatcheries because of the absence of any remnant wild populations. The impact of hatchery fish on wild populations has been greatly studied but remains controversial. Hatchery fish, released in large numbers, can overwhelm smaller populations of native fish through competition for available food. Hatchery fish can also decrease genetic diversity of wild populations, which may weaken the overall population's ability to adapt to different flow and thermal conditions.

Further, the maintenance and restoration of resident fish populations is a factor. Many important resident fisheries exist in U.S. and Canadian reservoirs and rivers. Kokanee, rainbow trout, sturgeon and burbot populations are important, both in a fisheries as well as an ecosystem context. These species have different habitat requirements and hydropower operations that favor salmon may in fact be harmful to resident populations. Thus, the trade-offs between resident and anadromous fish hydropower operations must be carefully considered.

5.3.2.2 Research Needs

- Economic value of anadromous fisheries, i.e., harvestable salmon runs
- Economic value of resident fisheries
- Economic value of power/flood control equal with non-ESA listed harvestable runs of salmon
- Currently available spawning habitat
- Potentially available spawning habitat (with reintroduction and with habitat restoration)
- Cost of various adult and juvenile passage options
- Evaluation of available passage technologies
- Cost of available passage technologies
- Impacts of hatchery fish on native populations

5.3.3 Maintenance of Lake Levels Alternative

This alternative requires an operation or series of operations that seeks to maintain high water levels in Arrow Lakes behind Keenleyside Dam,. This objective was identified by interviewees as a key goal of most residents of the West Kootenays in Canada, but is likely to extend to (and thus should be discussed and investigated for) other reservoirs such as Lake Koocanusa behind Libby Dam, and Dworshack. In the past, residents have favored these levels for recreational and aesthetic reasons, but now, there are also power benefits associated with keeping Arrow high. In addition, dust and economic losses associated with low lake levels are a factor. This alternative could be combined with either approach under ecosystem function Alternative 1, which focuses on anadromous fish runs in the United States, or can be viewed as a stand-alone alternative. It may be incompatible with Alternative 2, the restoration of anadromous fish to Canada, although that assumed incompatibility may require analysis.

5.3.3.1 Driving Forces and Associated Uncertainty

The ability to provide reasonable flood control while maintaining high lake levels is the primary driving factor of this alternative. Water supply and timing of runoff is a key uncertainty. However, the greatest uncertainty lies in the political will behind this versus Alternative 2 for return of anadromous fish to Canada and what the relative benefits and tradeoffs of each might be for the economic, cultural, and ecosystem health of the upper basin.

5.3.3.2 Research Needs

It is difficult to achieve this objective in the context of a prescribed flood operation, although current operation does allow B.C. Hydro to dedicate storage at Mica Dam for flood operations instead of at Arrow. Understanding how this alternative fits with other interests to achieve flood control and power production will be important to an informed dialogue. In a Treaty continued outcome, B.C. Hydro will still have to operate Treaty storage for the power operation. Arrow may be drawn down where such an operation optimizes generation in both countries. In a Treaty terminated outcome there will no such requirement and generation at Canadian facilities will be optimized by keeping Arrow high. Keenleyside, the Arrow dam, was originally built without generation. There is some opportunity to install additional generation at Arrow. Just how much additional generation is possible in a high lake level scenario and the cost of doing so should be investigated. In addition, basin residents will need information on the relative benefits, tradeoffs, and costs between this alternative and Alternative 2 contemplating return of salmon to Canada. It should be noted that the installation of additional generation capacity at Arrow has been explored in the past with some thought that it would benefit fish flows in the United States. This concept should be revisited.

5.3.4 Ecosystem Function Scenario

As noted above, scenario development involves identifying a goal then backcasting to identify decisions that must be made today to position the basin to achieve those goals within the range of uncertainty regarding the future and despite surprises. All of the alternatives discussed above have the common goal of improvement in ecosystem function within the basin. One way to cast

decision-making in a way more likely to achieve this is: when a choice must be made between two approaches, the one that more closely mimics a natural system should prevail. This leads to a preference for floodplain restoration over storage for flood control (while recognizing that both will probably continue to be necessary if the goal of limited harm is to be achieved); a preference for mimicking the natural hydrograph (while recognizing that a true natural hydrograph cannot be achieved while maintaining power production); a preference for moving anadromous fish in the river (as opposed to truck and barge programs); and a preference for wild fish over hatchery production (while recognizing that it is unlikely that fish populations in the basin can be maintained without hatcheries). Finally, the fact that many of the uncertainties cannot be resolved without experimentation on the ecosystem itself may call for a conservative or "precautionary" approach to adaptive management coordinated across the entire system.

6. Negotiation and Implementation of Columbia River Agreements and Management

This section returns to the interview data to address both negotiating an agreement and ongoing management of the Columbia River Basin system thereafter. Interviewees were asked about what has worked well with the Treaty and also ways that management could be improved. Based on the responses, five primary areas have been identified that relate to both the process of negotiating a decision and implementing the decision to reach the desired outcome for river system management. The following five areas are each addressed below: need for greater transparency; need for input; questions that require research before choosing a means of implementation; actual implementation; and restitution. These sections will reflect interview data, followed by a section on our own discussion of the approaches the basin might consider.

6.1 Need for Greater Transparency

One of the prevailing subjects in interview responses was a need for greater transparency at two different times: (1) during negotiation; and (2) during implementation. People interviewed are familiar with and critical of the nature of negotiations for the original Treaty. The closed-door negotiations provided little or no transparency regarding agendas, compromises, or coordination between the U. S. and Canadian governments. Answers also indicated a perception that remnants of this closed-door behavior are still present in current implementation and coordination. Though present-day management is becoming more transparent as a result of greater coordination between agencies and the required processes embedded in domestic laws, the process is thought to continue to limit the relevant information to a small group of interested parties. For example, people perceive that modeling by the U.S. Entity is a closed process where the public may only view the results. To address these concerns, stakeholders are interested in having discussions made in public. People seek transparency should occur throughout the process, rather than simply at the end or only at the public's request. Such an approach will also address concerns about implementation at the entity level if the practice were simply continued. When discussing transparency, interviewees raised a second issue—whose input should be included?

6.2 NEED FOR INPUT

In general, interviewees felt that a greater number of interests need to be addressed than were taken into account during initial Treaty negotiations. Current participants as well as participants necessary to negotiation must, therefore, decide whose input should be considered and how it should be managed. This issue, similar to transparency, needs to be addressed on two levels.

. The need for more or less public input is not synonymous with whether additional interests need to be addressed–rather, the question of public input asks who should provide input in relation to broader environmental and social interests. In fact, interviewees gave mixed responses when addressing the need for greater public input. These responses ranged from a consideration of greater public input as convoluting the process, to a desire for greater public input Thus, it is important to define who represents those interests – i.e. who is a stakeholder? One interviewee noted that this definition is especially necessary for the United States and Canada to comply with a multitude of laws requiring meaningful consultation and informed consent with Native Americans and First Nations. In some aspects, these laws require not only consultation, but also accommodation. It will require looking at what the legal, including treaty-based and constitutional, duties require of the federal governments. It will also be necessary to a look at how property rights, such as prior appropriation water rights, will be affected and how those interests will be represented.

Regardless of whether public input is increased or maintained, respondents have indicated that a comprehensive mechanism for managing those comments is needed. One suggestion was managing the public input through an advisory panel. This may be something similar to the current sovereigns process developed by the U.S. Entity, but the panel would additionally be assigned to facilitate the public dialogue and then present it to the sovereign working group or other similar entity representing the interests in the informal and formal discussions. Another opportunity to manage input that was raised might be through a neutral facilitator. The function of the Universities Consortium on Columbia River Governance in providing a neutral, informal forum for a cross-border dialogue is also important in this regard. Because the Consortium already exists and covers many geographical locations in the basin, it may also provide an effective infrastructure for compiling, summarizing, and presenting public remarks.

Interviewees named agencies and the political bodies responsible for implementing the Treaty components as a second level for greater input. This includes input from both federal agencies and the sovereigns. For example, the NWPCC is composed of representatives of the states, yet some interviewees indicated that the states' interests in the river were not always clearly defined and sometimes the sovereigns' policies clearly conflicted with one another, making it difficult to achieve a consensus or overall plan through use of the NWPCC. To illustrate the difficulty of consensus among the states, an interviewee indicated that Washington and Oregon have taken opposite approaches to water appropriation in regards to fish and stream health. Oregon refused to allow more diversions while Washington simultaneously allowed more water to be drawn from the river system. In addition, the upstream and downstream states frequently disagree on NWPCC matters. To resolve and manage such conflicts, input from and between the sovereigns interviewees seek and increase in communication regarding water management.

Similarly, there is an indication that broader involvement and input from the federal agencies that are currently managing the river system is necessary. BPA and the Army Corps of Engineers participate in the U.S. Entity while the Bureau of Reclamation also manages numerous dams on the Columbia River and its tributaries. The U.S. Entity has developed the federal working group composed of representatives of the federal interests in the basin which may already be serving this purpose in Treaty review.

6.3 QUESTIONS THAT NEED TO BE ANSWERED BEFORE CHOOSING HOW TO IMPLEMENT

As the process moves from discussions to negotiations, important questions should be answered to determine the scope of the cross-border dialogue. As noted above, many interviewees felt the question of what can be accomplished below the international level is the first question to ask. However, for the purpose of facilitation of a cross-border dialogue, our scenario approach seeks to first identify the benefits people seek from the basin, then to ask how those benefits can be achieved in light of the international border. To separate the interview data from this scenario approach, the following sections first describe the interview data, followed by how these issues might be handled in sequence under the scenario approach.

6.3.1 WHAT ARE PURELY DOMESTIC ISSUES? CAN WE ACCOMPLISH SOME OF OUR GOALS DOMESTICALLY?

Interviewees expressed the opinion that some Columbia River Basin issues need not be addressed at an international level. Some interviewees think that the United States and Canada should bring to the table only those issues that require international cooperation and input, thereby narrowing the scope of discussions. For example, some of the environmental laws that the United States entities are required to comply with have an effect on how the river system is managed, but some interviewees believe this need not be considered an international issue.

Interviewees has differing views on whether separate of issues between those requiring international attention and those that can be left to domestic action should be a process that occurs separately on each side of the international border, or jointly. Some respondents indicated that the sovereign working group (the representatives of states and Tribes currently providing input to the U.S. Entity review process) along with the U.S. Entity should first determine United States goals and interests. At that point, they can determine which goals and interests can be accomplished domestically, without coordination with Canada. Others identified the need to jointly develop a basic understanding of what the United States needs from Canada and vice versa, than eliminate aspects from the international discussions that do not fit within those needs

Interviewees also raised the possibility that, although certain goals may be purely domestic for one country or the other, achieving that goal may require international cooperation. In this context interviewees raised the possibility that some of the United States's domestic goals may not align with the interests of Canada or may conflict with international management schemes. In the former situation, interviewees suggested it will be important to try and accomplish them independently. However, in the latter, domestic goals that affect how a United States and Canadian agreement will be addressed may nonetheless require an international discussion. This leads to a second and related question.

6.3.2 What can be accomplished at a level below the treaty?

If domestic and international goals align or if international coordination is required, interviewees remained interested in exploring which goals can be accomplished at a level below the treaty. Some point to the management of Libby Dam can serve as a model for this process. The Libby Coordination Agreement has been considered a very successful agreement and mutually beneficial to both sides. The agreement must be implemented in a manner that is consistent with the Treaty but did not require Treaty modification. Yet, it accomplished goals for both the United States and Canada. Of equal importance to some interviewees, it provides an example of an agreement negotiated on a regional level. Some interviewees indicated that more agreements made in a similar fashion may alleviate the need to address some of the issues in treaty negotiation at the international level. Research will be needed on how far the treaty can be supplemented or changed without triggering formal requirements and ratification.

6.4 Actual implementation

Many interviewees indicated that the treaty and its management has generally worked very well and carried out precisely the intended purposes of the agreement. Still, interviewees see room for improvement and a greater scope of purposes in current discussions. Some believe this ability for improvement and greater scope creates the need for new or modified approaches to implementation. Interview answers regarding implementation included four discrete considerations: suggested approaches to management; a need for flexibility for changing circumstances; means to implement change; and ecosystem function integration.

6.4.1 Suggested approaches to management

While the Libby Coordination Agreement has been successful and some suggest broadening that approach, others suggest that such an approach through a series of agreements that occur below the treaty level may jeopardize achieving an overall goal for the basin. Those who seek broader regional and more diffuse control tended to suggest use of a series of agreements below the international level whereas others suggest that a single unified management international authority is necessary to achieve basin-wide goals.

6.4.1.1 Broader regional control and management: Working below the treaty level

The advocates of regional control suggest that it will give greater weight to local knowledge. Some suggest that the use of local knowledge is essential to management of a complex system. It will allow management based on more realistic empirical assessments rather than on theoretical projections. However, concerns were also expressed that a regional approach may create gaps in basin communications that result in a failure to address regional causes of basin problems.

6.4.1.2 Unified management: Working at the international level

Those who suggest this approach envision the possibility of creating a single international management authority. Rather than having three primary agencies – the BPA Administrator, the

Division Engineer of the Northwestern Division U.S. Army Corps of Engineers, and B.C. Hydro – acting in coordination, some suggest consolidation of their separate functions into a single international managing agency. The rationale is that a single entity would provide more opportunity for basin-wide transparency, communication, and consistent management. Some indicate that a unified authority would be more able to address the complexities of the systems as they relate to one another than a regional authority. However, some people caution that such a unified authority will encounter federal obstacles regarding sovereignty and state autonomy.

6.4.1.3 MAINTAINING MANAGEMENT AS IS

Though it was not "suggested" as an approach (probably because interview questions focused on change), continuing status quo management, through the Entities is also an option. Many interviewees had no suggestions for improving the management schemes and a fair inference would be that current structures are both adequate and effective in implementing Columbia River Basin goals, both domestic and international.

6.4.2 NEED FOR FLEXIBILITY

Whatever the approach to management, interviewees repeatedly stressed the need for greater flexibility to accommodate future changes in circumstances. The current management structure is effective for the purposes of the treaty, but some noted that the structure was too rigid to accommodate changing values with respect to use of the river system. Some of the bases for these views appear to include the following. When the Treaty was first negotiated, economic concerns were the focus of the U.S. government. Thus, the parameters of the Treaty were strictly defined to accommodate the narrow focus of hydropower and flood control. In the decades following the Treaty's ratification, the dissenting voices, largely excluded beforehand, such as fish and Tribal interests, starting gaining recognition and power. Yet, the Treaty itself provided no means for accommodating those constituents. Thus, any deviation from purely hydropower and flood control interests has come through awkward domestic accommodations. For example, the United States reduces power production to accommodate salmon, but must pay the Canadian Entitlement regardless of whether the projected amount of power was actually generated. On the Canadian side, the construction of the required dams in the treaty gave Canada little to no flexibility to accommodate rural needs or First Nations. Reservoir operation requirements prevent Canada from accommodating recreationists and others living on and near the Canadian reservoirs. Rather than continuing to limit options, the Treaty could be modified and improved by providing a mechanism for adapting to change without the need for a new Treaty.

6.4.3 PHASED-IN CHANGES

Interviewees suggested the need to phase in any change in the Columbia River Basin. They indicate that any major modifications or adjustments – whether in the approach to management, the actual structure of operations, or the integration of broader interests – should be implemented over time because immediate and comprehensive modifications may create discord, confusion, and frustration.

6.4.4 INTEGRATING ECO-SYSTEM FUNCTION

Interviewees that identified ecosystem function and health as a third, and possibly co-equal purpose, necessarily imply that a new treaty is needed. As part of this, interviewees suggested that the involved parties should consider adding a technical advisory team that focuses on ecology in the river system. While the NWPCC balances some of the interests between power and fish, this new technical team would be international and represent ecological expertise that includes resident fish and other ecological values. As studies become more comprehensive on anadromous and resident fish, and on the related issues of erosion, sediment, and other water quality issues that affect fish health, a technical advisory team to gather and interpret data and create solutions will become increasingly necessary.

6.5 RESTITUTION

Although most discussion by interviewees concerning ecosystem function focused on the future, some within the basin continue to seek restitution for the damage caused by implementation of the 1964 Treaty. There is little question that the basin development has caused problems for those residing in the upper portion of the basin. Some view renewed discussions as an opportunity to develop a way to address past harm. The damages to ecosystems have affected Native Americans' and First Nations' communities, values, and cultural resources. Suggestions are that any approach to implementation should include a way to evaluate and restore or compensate for each of these. Tribal communities are taking a larger role in discussions and these may include determining appropriate compensation for lost cultural resources, protecting remaining resources and ameliorating ongoing and future damage. This requires recognizing the value of these resources to the communities as a first step. Other, more concrete considerations may include restoring flows and maintaining or increasing lake and reservoir levels.

6.6 IMPLEMENTATION CONSIDERATIONS

We now turn from the interview data to discussion of approaches to implementation that may address some of the issues raised. The following discussion is focused on basin-wide issues and does not address issues such as restitution which remain important considerations. Based on the interview data set forth above, approaches to implementation should take into account: (1) the desire for greater regional and public input to decision-making; (2) the desire for greater flexibility to respond to future change without renewed treaty negotiations when change occurs; and (3) the suggestion to phase-in some of the changes that involve a high degree of uncertainty. Although there is a strong desire among many to keep changes below the international level, it is difficult to do that consistent with the expressed goals. However, it should be noted that although interviewees characterize regional control to be distinct from international negotiation, these may not be mutually exclusive. When a basin crosses a regional boundary, international agreement may be the only means to authorize regional control at the scale of the basin (see e.g. Vogel 2011 analyzing how the 1964 Treaty led to development of the Columbia River Basin as an economic region). One approach that might walk the line between those seeking stability under the current regime for hydropower and flood control and those seeking to elevate ecosystem function to the international level might be to accomplish the first under cooperative agreements and the second with a new, separate international treaty. The following paragraph describes one way these separate treaties might then be reconciled.

Use of a separate treaty to address ecosystem function could establish a commission modeled after the Pacific Salmon Commission (Pacific Salmon Treaty 1985, 1999, 2009), for purposes of providing decision-making authority for response to changed conditions. Technical operation for hydropower and flood control would remain at the Entity level under the existing treaty, but conflict between the two separate efforts might then be resolved by the commissionTo assist in this process, the new treaty address must address the role of ecosystem function in the basin in relation to hydropower and flood control by authorizing the commission's authority to include those purposes and spelling out whether a hierarchy or equal treatment is intended. Authorization of an international technical committee for ecosystem function could also be provided in this agreement. The commission would be composed of state, tribal, First Nation, provincial and local representatives, providing the regional oversight and flexibility sought by many interviewees. Further research on models for this approach may be warranted.

7. Information and Research Needed to Inform a Cross-Border Dialogue

The main themes described above – maximizing power, minimizing flood damage, and enhancing ecosystems – are accompanied by a set of driving forces and uncertainties related to the degree of difficulty in evaluating and comparing the scenarios and alternatives connected with each theme and understanding the tradeoffs among efforts to achieve the goals of each theme. Our knowledge of the Columbia River system is far from complete. Based on our interviews, we identified two broad categories of knowledge gaps.

The first category includes an array of economic, social, legal, and technical uncertainties that cannot be clarified through further research. Questions surrounding the outcome of Endangered Species Act litigation or the type and timing of future developments in power technology fall into this category. This category is addressed above by the process of scenario planning and the suggested use of a phased and flexible approach to implementation. The solution to irreducible uncertainty is positioning the basin to adapt, as opposed to additional research.

The second category encompasses a range of questions that can be answered by new studies, some of which are already underway in the basin. Some of these gaps were specific to certain scenarios while others cut across every scenario. The following sections discuss crosscutting research needs. Sources for identification of these areas and of the studies currently underway included the interviews and class research. As a preliminary matter, it should be noted that the Entities have already released the results of modeling for alternatives that include the following at several levels of assured flood control termed the Phase 1 studies: (1) continuation of the treaty as is; (2) continuation of the treaty with expiration of the assured flood control; and (3) treaty termination (United States and Canadian Entities 2009). In addition, the U.S. Entity has released supplemental studies that look at the overlay of fish flows currently required under the ESA on the Phase 1 alternatives (United States Entity 2010). In addition, the U.S. Army Corps of Engineers is in the process of a flood risk management study for the U.S. portion of the basin. It is our understanding that this study does not include non-structural alternatives such as floodplain restoration.

7.1. Cross-Cutting Research Needs

The following sections identify research needs associated with the physical, biological and social systems. The paper addressed scenario-specific research needs in the appropriate scenario and alternative sections, but some is repeated here to emphasize the cross-cutting nature.

7.1.1. Climate change

Perhaps unsurprisingly, interviewees consistently identified climate change as a key uncertainty affecting the physical processes of the entire Columbia River system. This primarily stems from the recognition that even modest warming can shift patterns of rainfall, snowfall, and snowmelt across the basin, which in turn complicates water resource management (Hamlet, 2011; Hamlet and Lettenmaier 1999). Previous studies suggest that such shifts generally cause reduced snowpack, earlier peak snowmelt, higher winter runoff, and higher evapotranspiration and that, in combination, these effects lead to lower summer and fall flows (Elsner et al. 2010; Lettenmaier and Sheer 1991). Thus, climate change raises questions about the adequacy of current flood control and hydropower operations under the Treaty as well as the ability to recover the river's lost ecological diversity (Lee et al. 2010; 2009). This lack of precision also reduces the value of predictions concerning the potential effects on electricity demand, precipitation patterns, and river flows (Northwest Power and Conservation Council 2010; Hamlet et al. 2010).

In response to those questions, interviewees suggested three general areas of inquiry. First, there was a general call for regionally focused models that improve on those used in the Intergovernmental Panel on Climate Change's Fourth Assessment Report. Similarly, others sought improved long-term forecasting tools as a means to plan for specific impacts rather than general trends. Work by the Climate Impacts Group at the University of Washington should be integrated with each scenario and simulation of potential changes in river operation.

7.1.2. Changing Technology and Renewables

New technology could drastically alter the existing framework of power for the Pacific Northwest. The high uncertainties of growth in wind and other renewable resources, transmission expansion, carbon trading, and market preferences make integration within the existing Treaty framework much more complicated and power supply and demand forecasting beyond the 20-year cycle of the NWPCC highly uncertain. Additionally, the existing infrastructure is aging and it is uncertain how long it will last and what future conditions will be when replacement becomes necessary. Infrastructure repair needs and short term transmission, energy demand and economic projections should be included in the evaluation of various scenarios, particularly as they relate to the question of whether continued benefits can best be met by joint U.S. – Canada operation.

7.1.3. Flood Control

In addition to the efforts to analyze flood risk management currently underway by the U.S. Army Corps of Engineers the following research is recommended. Floodplain mapping that includes habitat connectivity for the entire basin would allow prioritization of areas for restoration. Cost

analysis and comparison to the cost/benefit of relying only on storage for flood control are needed. Although this area of research is identified in the flood control scenario, it is restated here to emphasis the cross-cutting nature. Any cost effective efforts to reconnect the river to the floodplain that reduce reliance on storage not only create habitat benefits, but free up storage for operation for power and ecosystem health.

7.1.4. ECOSYSTEMS

The interaction of fish health with land based ecosystems, the impact of ocean conditions, and managed fisheries compared to a natural hydrograph are variables that make the ecosystem response quite unpredictable. Uncertainty also exists in the economic analysis of species preservation and habitat conservation. Diverging ethical stances and reliance on non-market valuation make it more difficult to analyze ecosystem values for alternative scenarios and muddies the communication of that analysis to the public and decision makers (Hamilton et al. 1999). Modeling and cost/benefit analysis is nevertheless needed to allow stakeholders to compare the various ecosystem alternatives and to understand their impact on power and flood control goals.

7.1.5. SOCIAL VALUES

Uncertainty in the values and the political will for various approaches can only be addressed through an informed and open public dialogue. Tools for managing a dialogue on the scale of a river basin are discussed below.

7.1.6. LEGAL

Past biological opinions help predict where endangered species litigation may be headed, but the cost, benefit, and impact of species protection remains highly speculative. Uncertainty in legal matters might also arise with respect to water deliveries, tribal cultural resources, or in restoring losses due to flooding or other impacts. Legal questions also surround interpretation of called upon flood control, the extent to which supplemental agreements are proper without a new treaty, and whether international law constrains how Canada could operate without a treaty. Issues such as the appropriate form of an agreement can be addressed through legal research, but issues such as the outcome of ESA litigation cannot.

7.1.7. IMPACT EVALUATION

Interviewees identified areas that do not require treatment at the international level, but nevertheless, a dialogue on various scenarios for international river operation will require evaluation of impacts on these areas. These include water quality including sediment and temperature, navigation, water rights, cultural resources, and recreation.

7.2 SCENARIO EVALUATION THROUGH MODELING

Assessing the impacts and tradeoffs of the foregoing alternatives and scenarios depends on both the availability of reliable information and the capability to convey that information in ways that

is useful for the Entities and stakeholders alike. Such decision support tools include models to optimize and simulate operations; economic analyses to measure feasibility, costs and benefits; and other methods to weigh qualitative criteria. Broadly speaking, these tools can be classified as either forecasting or systems dynamics models. Both serve a decision support function, but the key difference is their technical accessibility and resulting transparency for end users.

7.2.1. FORECASTING MODELS

Forecasting models are already extensively used to plan operations for flood control, hydropower, and ecosystem needs throughout the Columbia River Basin. The various agencies and organizations involved with the Treaty studies possess a broad range of capabilities that support decision making in the Treaty review process. Further, our conversations with Basin modeling experts indicate a high level of cooperation with respect to information sharing and modeling. However, the models' technical complexities impose a significant barrier for the average stakeholder. Although the models are time-tested and produce demonstrably reliable results, few in the basin have the technical skills to manipulate these sophisticated models. As a result, the ability to test scenarios is limited to groups with a high level of technical expertise, which may leave some interested stakeholders out of the process. The following paragraphs describe some of the modeling capability available.

7.2.1.1. NORTHWEST POWER & CONSERVATION COUNCIL

The Northwest Power and Conservation Council's Generation Evaluation System (GENESYS) is one example of a model used in the region (Northwest Power and Conservation Council 1987). Tasked with power planning for the region, the Council provides a guide for BPA to manage power while accounting for fish and wildlife. Based on a similar model used by the BPA, GENESYS incorporates a variety of data to forecast electrical demand and supply, estimate environmental costs and benefits, calculate the present value cost of efficiency measures and alternative resource plans, and account for the effects of market uncertainty and risk. These data are sourced from and shared among various agencies and research institutions across the Basin. The model then compares these data in a Monte Carlo simulation, a process by which uncertain variables are randomly combined in hundreds of individual simulations to produce a range of potential results. By accounting for random variations in uncertain variables such as flow and power supply, the model can be used to forecast system performance across a range of conditions. The Council then uses GENESYS to simulate Columbia Basin project operations, evaluating the results as part of its power-planning mandate (Northwest Power and Conservation Council 2011).

7.2.1.2 BONNEVILLE POWER ADMINISTRATION

As noted above, the Bonneville Power Administration uses similar forecasting models for its operations planning. The Phase I report was based on information from BPA's hydrologic simulation model that uses rule curves and flow/storage constraints to achieve operating objectives, especially for power, flood control, fish flows and spill, and recreation (U.S. Army Corp of Engineers et al. 2009).

7.2.1.3 ARMY CORPS OF ENGINEERS

Likewise, the Army Corps of Engineers uses a variety of forecasting models to support ongoing operations and as part of the Treaty studies (such as HydSim). The Army Corps is also the lead agency for evaluating changes in the Treaty's flood-control operations. Presently, the agency is engaged in a series of studies aimed at quantifying flood risk costs and benefits. In particular, the Army Corps is gathering data and developing tools to determine how called-upon flood control operations might work if the Treaty's flood control provisions were allowed to expire. It is also expected to evaluate the effects of increasing the maximum flood flow at the Dalles, Oregon from 450,000 cfs to 600,000 cfs. This process is ongoing and the Army Corps has not yet publicly released any findings or modeling methodologies. Nevertheless, this effort will be central to the United States' negotiation strategy, as flood risk tolerance in the lower Columbia is a key uncertainty.

The purpose of these sophisticated modeling efforts is to anticipate potential changes in the system and evaluate alternative scenarios for managing the Columbia River. Yet, these efforts demand staff and resources that are generally not available to many stakeholder groups throughout the basin. Even though models like GENESYS are in the public domain, their scenario-testing power remains largely unavailable. With the recognized need to engage a broader array of stakeholders, it becomes necessary to translate vast amounts of information and complex models into an accessible and understandable format for the general public. The next section explores one possible solution.

7.2.2. PARTICIPATORY SYSTEMS DYNAMICS MODELING

Because the Columbia is a complex social-ecological system, it is often difficult for stakeholders to evaluate the effects of competing policy proposals. To illustrate, consider a Canadian stakeholder's proposal to maintain higher summer elevations in the Canadian reservoirs to improve recreational access and resident fish. While the resulting local benefits may be apparent to that stakeholder, the downstream effects on U.S. hydropower or ecological needs may be less obvious. To evaluate such a proposal in the context of the broader system, the stakeholder would need to integrate the effects of retaining water in certain Canadian reservoirs on downstream operations over the course of months or even years.

This thought experiment is nearly impossible because of the feedback and time lags inherent in a system as large and complex as the Columbia. The stakeholder's proposal might cause an unacceptable decrease in hydropower production or ecological flows. Conversely, it could provide improved late summer flows to serve summer power demand while improving flow and temperature for fish. Yet these downstream effects would be difficult to anticipate without the aid of computer simulations. The stakeholder's ability to participate in the process of evaluating policy alternatives for the Columbia Basin thus depends on her ability to access and manipulate a model of the entire system. To date, that access has been limited and the technical barriers to participation have remained high. Despite calls for broader stakeholder participation in Columbia River governance, relatively few members of the basin community are able to use computer models as a decision support tool.

Our interview results indicate a strong desire for a less technical and more widely available model of the Columbia River system. Although the River is already extensively modeled for power supply, flood control, and ecological forecasting, these studies are technically complicated and often inaccessible to stakeholders outside of academic, governmental, or industry circles. This results in a perceived lack of transparency as operational decisions are premised on complex modeling studies with limited public input or participation. Consequently, there is an acknowledged need for a parallel modeling process that engages a broader array of stakeholders in proposing and evaluating new operational scenarios for the Columbia basin.

One promising way to address this need is through hands-on scenario testing using a systems dynamics model of the Columbia River. Systems dynamics is "a method of analyzing problems in which time is an important factor, and which involves the study of how a system can be defended against, or made to benefit from, the shocks which fall upon it from the outside world" (Coyle 1977). In other words, systems dynamics models integrate the effects of many changing variables over time. These models are particularly suited for complex water resources systems like the Columbia because they allow users to simulate the effects that changing precipitation, dam operations, consumptive use, and other variable have on streamflow. Further, the model can convert these streamflow effects into estimates of reservoir elevations, hydropower revenues, or even fish stocks. In this way, a systems dynamics model is not so different from the institutional forecasting models that are already used on the Columbia. The key difference is that a systems dynamics model is used to investigate interrelationships between these variables rather than to precisely predict their value at some point in the future.

A good systems dynamics model provides reasonable estimates, but it is not a substitute for a more complex forecasting model. Instead, the benefit of systems dynamics modeling is rapid simulation of how a variable change in one part of the system–higher summer Canadian reservoir levels, for instance–affects the other parts. This nimbleness allows the user to uncover patterns in the system's behavior and understand the constraints that govern it. With an understanding of these patterns and constraints, the user is able to more effectively evaluate policy recommendations. Furthermore, the user can rapidly sift through numerous alternative policies and identify a handful for more detailed studies using the institutional models. Thus, a systems dynamics model compliments rather than supplants more specialized forecasting models.

Systems dynamics modeling has been applied to a variety of complex, multi-stakeholder environmental issues such as air quality, water quality and quantity, and biological conservation management (Beall 2007). Often, the model is presented in the form of an internet-based graphical interface that allows the user to adjust key variables and to simulate the effect of these changes over a set timeframe. One example is the Palouse Basin Systems Model (Beall et al. 2011). These interfaces remove some of the technical complexity from the modeling process and allow the user to focus on comparing simulation results rather than wrestling with the underlying model architecture. This promotes "group learning [by] conveying the effects of feedbacks and time lags [and] establishing a shared vision of the problem" (Beall 2007). Systems dynamics models thus provide an opportunity for lay people to develop a comprehensive understanding of complex systems–a necessary first step toward informed participation in the decision-making process.

Applied to the Columbia, a publicly available systems dynamics model could be a valuable tool for educating stakeholders and testing operational scenarios. Of course, this requires a reasonably accurate model of the system. Fortunately, researchers at the University of Washington have already developed the Columbia River Simulation Model (ColSim) (Hamlet et al. 2010). This model has been used to evaluate the effects of climate variability on the Columbia's operating system design, the economic value of long-lead streamflow forecasting for hydropower, and various policies for mitigating the effect of climate change on the Basin's water resources (Miles et al. 2000, Hamlet et al. 2002, Payne 2004). Although ColSim has only been used as a research tool to date, it could be adapted into an internet-based decision support tool like the one described above. Additional data collection, model validation, and user interface development would be necessary to accomplish this task.

Once adapted into a decision support tool and made publicly available, a model like ColSim could serve a number of important functions in a scenario evaluation process for the Columbia River Treaty operations. The first and perhaps most important function is educational. By graphically depicting the potential effects of new operational regimes on various system components (e.g., reservoir elevations, dam releases, projected flood damage, or power production), the model would aid stakeholders seeking a broader understanding of the system. In addition, the model could also serve a consensus-building function by allowing stakeholders to test policy ideas and weigh the costs and benefits of their proposals. Finally, it could be useful for screening scenarios that warrant more detailed technical studies while weeding out ones that produce unacceptable outcomes. Whether dedicated to education, building consensus, or scenario screening, a systems dynamics model could increase both the level of public participation in and the transparency of the Treaty evaluation process.

In summary, the capability exists to transform information into useful decision support tools. However, in some areas where information is lacking, a discussion should take place to determine necessity of information and if other estimates will suffice. Discussions should also assess the value of making models and data available for the general public to help inform the decision process. On this track, the U.S. Entity has assured that moving forward, it "is fully committed to an open, collaborative, and region-wide engagement process, so that all voices in the Pacific Northwest that wish to be heard can inform and identify the best possible policy options in the 2014/2024 Columbia River Treaty Review" (U.S. Entity for the Columbia River Treaty 2010).

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APPENDIX A: Institutional Review Board Approval

To: Barbara Cosens

From: Traci Craig, PhD
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

IRB No.: IRB00000843

FWA: FWA00005639

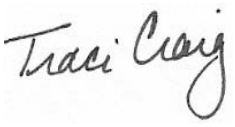
Date: Approved as Exempt December 23, 2010

Project: Columbia River Treaty Scenarios (10-104) has been approved as Exempt under Category 2.

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the above-named project is approved as exempt from review by the Committee. Please note, however, that you should make every effort to ensure that your project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.

Traci Craig



APPENDIX B: Interviewees

Name	Affiliation
William Barquin	Legal Department, Kootenai Tribe (Portland Office)
Bill Bradbury	Oregon Representative, NWPCC
Gwen Bridge	Okanagan Nation Alliance, Natural Resource Manager
Donna Darm	Former NOAA Fisheries Columbia Policy Lead
Greg Deck	Vice Chair, Columbia Basin Trust
Bill Drummond	Manager, Western Montana Electric Generating and Transmission Cooperative
John Fazio	NWPCC Staff, Senior Systems Analyst
Jim Gustafson	Nelson, B.C., Chief Administrative Officer of the Regional District of Central Kootenai
Alan Hamlet	University of Washington Climate Impacts Group
John Harrison	NWPCC Staff
Bob Heinuth	CRITFIC
Brian Lipscomb	Confederated Salish and Kootenai Tribes. Director of department of energy
Bruce Measure	Montana Representative, NWPCC
Terry Morlan	NWPCC, Director Power Planning Div.
Tim Newton	Canadian Member of the Permanent Engineering Board for the Columbia River Treaty
John Ogan	Attorney for Warm Springs Tribe
Richard Paisley	UBC law professor, Member UCCRG
Joe Peone	Director, Natural Resources, Colville Tribes
Jim Ruff	NWPCC Staff, Modeler
John Shurts	NWPCC General Counsel
Lorne Sivertson	Consultant, Former Chair of Columbia Power Corporation
Steve Smith	Consultant for Colville Confederated Tribes and Upper Columbia tribes
Mary Lou Soscia	EPA, Region 10, Columbia River Program
Dick Wallace	Washington Representative, NWPCC
Anita Winkler	Executive Director, Oregon Water Resources Congress
Jim Yost	Idaho Representative, NWPCC

APPENDIX C: Recommended Interviews

Name	Affiliation
Bill Bakke	Native Fish Society
Chad Colter	Fort Hall Indian Reservation
Bill Dobbins	Douglas PUD (Washington)
Kindy Gosal	E.D. CBT
Bryan Gruber	Attorney
Keith Kutchins	UCUT Policy Analyst
Jim Litchfield	
Jim Mattison	Board CBT, Retired controller for water rights, BC Hydro
Pat McGrain	Bureau of Reclamation, Boise
Garry Merkel	Board, CBT
Andrew Monroe	Grant PUD (Washington)
Tom Myrum	
Tim Personius	Bureau of Reclamation, Boise
John Platt	CRITFC
Chris Sanderson	outside counsel for BC Hydro
Jeff Smith	Chelan PUD (Washington)
Bruce Suzumoto	NOAA Fisheries current Columbia Policy Lead
Howie Wright	Okanagan Nation Alliance

APPENDIX D: Interview Questions

Lead-in Statement

I am part of a class at the University of Idaho College of Law that is helping to gather information to develop alternative scenarios for international cooperation in the Columbia River Basin. We are seeking to learn what people would like to see researched and discussed as part of the evaluation of the 1964 Columbia River Treaty. After two symposia held by the Universities Consortium on Columbia River Governance (i.e. UI, OSU, UW, U.Montana, UBC, U.Calgary), a number of stakeholders in the basin have expressed interest in a continued effort to provide a forum for a cross-border dialog to identify areas of mutual benefit and to allow discussion of alternative scenarios for international cooperation concerning the Columbia River. This process will complement the more formal process that each country must enter into to assess the Treaty future given the Treaty provision that allows either country to terminate the Treaty as early as 2024 with 10 years' advanced notice and the transition to Called Upon flood control in 2024. Because the formal processes are limited to national boundaries, it is the hope that the informal process will allow identification of areas of mutual benefit across the 49th parallel. The following interview questions are one step in identifying areas of interest for use in developing scenarios to be discussed at the next forum provided by the Consortium.

Background Questions

1. What is your interest, role and history regarding the CRT
2. What is the most important benefit the Columbia River provides and why? What other benefits provided by the river do you value? What benefits should the river provide, or provide more of, but does not at present?

CRT and Scenario Development

3. The focus of the CRT is flood control and hydropower and implementation is by appointed entities [Administrator of BPA, Division Engineer of Northwestern Division USACE, BC Hydro]. What has worked well in both the focus and implementation of the CRT, what hasn't worked well?
4. In a process to evaluate the CRT, are there any additional purposes you would like to see explored in relation to the CRT? What type of CRT scenarios or alternatives would you like to see modeled to evaluate these additional purposes?
5. What issue would possibly be solved or opportunity achieved by accomplishing the suggested Treaty alternatives?
6. What do you view as the obstacles or constraints that may inhibit achieving the desired outcomes from these Treaty alternatives?

Scenario Evaluation

7. How would you quantify the results? What would you actually assess or measure?
8. How would you balance competing uses and interests?

9. What are the tradeoffs among competing uses and interests?
10. Can you identify any opportunities for mutual benefit across the international border in achieving these purposes?
11. Can any of these be accomplished outside a treaty or is international cooperation essential?

Education

12. Do you feel you have enough knowledge of this issue to engage in the evaluation and process?
13. Based on your current knowledge what more would you like to know to be able to engage in a discussion of different scenarios and priorities for the CRT? What are the biggest gaps in our knowledge? An understanding of:
    a. The Columbia River Treaty
    b. Flood control
    c. Hydropower
    d. Ecosystem Functions
    e. Irrigation, navigation, water supply and other river uses
    f. Modeling
    g. Climate change
    h. Economic data
    i. Statutory and regulatory requirements
14. Who should provide this information and how?
15. What type of information can your organization contribute to the process?
16. Who do you know that can contribute information?

Treaty Implementation/Administration

17. What changes in the process of CRT administration/implementation would you like to see explored?
18. What changes in participants in CRT administration/implementation would you like to see explored?

Regional Engagement

19. What are your thoughts on design of the process or processes for participation by state and tribal governments and the public?
20. Who needs to be part of an informal dialogue on evaluating the CRT? At what level?

Wrap-up

21. Are you willing to participate in an informal cross-border dialogue on various scenarios for international cooperation on the CRT?
22. Is there anyone else we should talk to?
23. Is there anything else you would like to share?

Appendix E: Themes Identified from Interviews

Power Themes Outline

- Let the Treaty continue to do what it does well – hydropower and flood control.
    - Maintain current levels to ensure maximum power return.
- Everyone uses power. Renewable energy generated by the river is the most important benefit after flood control.
    - People in the region will not accept a treaty that diminishes the value of the power system.
- The region depends on flood control and reliable power generated by the river.
    - Demand will only increase in the summer months.
    - The value of sale of summer power could mean that Canada would continue to operate as it currently does regardless of whether the downstream benefits continue.
- How does the development of other renewable sources of energy change the operations on the Columbia?
- Some believe that power is important, but not the most important benefit.
    - Some think that while the supply of power is important, the focus has been too narrow for too long.
    - Some think that power is important but it is just a secondary benefit to thatof the natural ecosystem.

Power Tradeoffs/Concerns

- We need to understand the trade-offs between energy & flood control.
    - Once we figure out changes in flow, then we can calculate impact on hydropower (this needs to be reflected in terms of cost/benefit)
- What will future needs be?
- If we did not have the dams then we would have to find an alternative means of power.
    - Could we sustain the economy in the Pacific Northwest without the cheap power from the dams?
- More should be done to study how we can maintain or even enhance the North American grid. Can the grid be extended directly from B.C. into Alaska?
    - Will significant changes need to be made in the current infrastructure?
    - How would Canada operate if the treaty were terminated?
- Experts disagree on whether the river can be managed for power without degrading other purposes such as ecosystem and recreation. Can the river be managed for power in a way that does not significantly take away from other purposes?
- Some think that we need to manage the river for flood control first and for power second.

Flood Control Themes Outline

- Flood control is the most important benefit that the treaty currently provides.
    - The key to the treaty is to spread the risk between the United States and Canada through the use of reservoirs and changes to the floodplain throughout the basin.

- Some think that we should manage for flood control by starting with the natural system (i.e. use of floodplains) and then determining how much storage control would be necessary to adequately control for floods.
    - Flood risk is decreasing due to climate change, which may allow the United States to accept more spring flood risk.

Flood Control Tradeoffs/Concerns

- The major information that interviewees in the U.S. want is how reliant is the U.S. on Canada to maintain flood control?
    - How would losing the Canadian storage affect U.S. tributary storage procedures?
    - How would a change in those procedures change the areas' standard of living?
- What would happen if the treaty lapsed and only the on-call flood control provisions were in effect?
    - Would timing of flood control become an issue?.
- Some believe that we have artificially increased our dependence on flood control by developing within the flood plain.

Ecosystem Themes Outline

- We need to look at the river as an ecosystem.
- Anadromous fish are a cultural icon for the region.
- Social conditions have changed on both sides of the border.
    - At the time the treaty was signed, there was little concern for the river's natural ecosystem.
- The river should be managed to have as close to a natural hydrograph as possible.
    - A natural hydrograph would decrease flooding risk and require less drafting in the spring.
- Need more balance in the management of the river.
    - The river cannot be managed to optimize any one purpose. Instead, it needs to be managed in a way that balances many competing interests.
    - There will have to be compromises –hydropower and the need for flood control must be considered, but ecosystem function is also necessary, what that balance is – I don't know.
- There is currently no incentive on the Canadian side to operate for the benefit of fish or the ecosystem.
    - If the U.S. is interested in maintaining anadromous fish then it should come up with a mechanism for compensating Canada for improved fish runs.
- First-nations in Canada strongly believe that it is important that anadromous fish be reintroduced to the mainstem Columbia in Canada. Some thought returning salmon to Canada would be a powerful symbolic gesture.
- Anadromous fish populations are of particular concern (though the focus should be on the ecosystem as a whole, not just fish).
    - First-nations in Canada strongly believe that it is important that anadromous fish be reintroduced to the mainstem Columbia in Canada. Some thought returning salmon to Canada would be a powerful symbolic gesture.
    - Others think that while returning Salmon to the Canadian portion of the Columbia is symbolic, it will likely not be a driver in negotiations because there are many practical problems associated with getting juvenile fish to the ocean alive.
    - Some think that the U.S. is already managing the river for an ecosystem purpose because the ESA is forcing it to.

- The river may have already crossed a threshold where it cannot recover its natural ecological function.
    - Anadromous fish may not recover in the Columbia. Therefore, the focus should shift to maintaining resident fish populations in the reservoirs.
    - Climate change may make it impossible for salmon to recover under existing conditions.
- There needs to be a comprehensive plan for the ecosystem function
    - Supplemental operating agreements are not an appropriate fix. An ecosystem purpose needs to be part of the treaty, even if it is just an addendum to the current treaty.
- Some think that while benefits to fish and the ecosystem are important, those values should not trump other purposes such as hydropower and flood control.

Ecosystem Tradeoffs/Concerns

- Managing the river for fish is a waste of public resources.
    - Should do cost-benefit analysis of the tradeoffs between power and flood control and fish and wildlife benefits.
- How do we manage the river in a way that protects both resident and anadromous fish?
- Does the use of the ESA to manage the river result in a judicial deadlock? Is there a better way to manage anadromous fish?

Implementation Themes Outline

- The fundamentals of the treaty need to remain in place.
- We should avoid modifications that would require legislative approval.
    - Decision-making should stay in the basin and we should avoid politicizing the river.
    - To the maximum extent possible we should modify the treaty through the use of ancillary agreements.
        - Operational agreements could be used to address dramatically changing reservoir levels and the associated impacts on the ecosystem.
- The primary question for both sides is whether there is still a need for cooperation.
    - There is no need to reach across the border to discuss a treaty if there is no need for a treaty.
- Participation
    - Tribes need to be involved in any formal negotiations. The Columbia River is of paramount importance to the Columbia River Tribes. Tribes need to be a part of formal discussion because the Tribes lived in the basin. They used and held waters for their cultural, spiritual needs as well as economic trade routes for fish.
    - More U.S. federal agencies should be involved (NWPCC, EPA, USFWS, NOAA, BOR).
    - Some believe that more public participation should be occurring.
        - Direct involvement would be difficult but is important.
        - Alternatively, some think that managed public involvement or representative involvement is better.
            - Use good governance – provide notice and an opportunity for the public to be heard, then take those comments into account when making decisions.
    - Some people think that more public involvement is not necessary. For these people, the public's interest in an ecosystem function is already coming to fruition through the ESA litigation.
        - Other parties need to be involved because some people do not trust the entities to implement an ecosystem purpose.

        - Some believe these matters should be left to the sovereigns.
        - There is also concern that the more people involved, the harder it will be to get anything done.
        - Transparency is important. Treaty implementation should no longer be closed from the public.
            - For some, the key issue is not more public participation but more transparency. For these people, it is more important that the public know what is going on rather than actually be involved.
- Ideas for increasing transparency and accountability
    - Establish some sort of an international management authority that could maintain the system as a whole. This would also provide a place for redress and notice and comment for public outreach.
    - Or, entities could remain in control of treaty implementation but with broader input from the public.

Implementation Tradeoffs/Concerns

- If the treaty is renegotiated, then the U.S. will not get as beneficial of terms as in the previous negotiation.
- Any changes should be phased in slowly.
- BC Hydro should not have the sole role of future implementation on the Canadian side.
- There is a need to move beyond management of just the Army Corps and B.C. Hydro.
- At the very least, entity meetings should cease to be closed. The public should at least be able to observe.

Miscellaneous Themes Outline

- More time is necessary to better understand all the ramifications associated with different options under the treaty – thus, and extension should be negotiated.
- Education of the public/entities/stakeholders on the treaty and the benefits the river provides is very important.
    - People need to better understand the impacts associated with this system.
    - People need to better understand the impacts associated with climate change.
    - A commission should be created that to inform all of the stakeholders in the basin and gather different ideas.
- Indigenous people have a right to depend on the river for sustenance.
- Coordinating safety standards for dams and disaster response would aid in reducing the risk of harm from floods.
- Cooperation that these discussions could generate between the sovereigns could be a benefit in itself.
- Renegotiation of the treaty could provide an avenue for restoration and/or compensation for the loss of cultural resources.
- Should the navigation and irrigation interests be represented in the process?
- To some, certainty in river operation is the most important benefit that the treaty provides.
- A new treaty should allow for more opportunities for reevaluation as time goes on. It should be reevaluated on a much shorter time frame than every sixty years.

PART II: OREGON STATE UNIVERSITY REPORT

COLUMBIA RIVER TREATY SYMPOSIUM PREPARATION: ALTERNATIVES DEVELOPMENT

Brendan Galipeau, Kim Ogren, and Jacob Petersen-Perlman

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Introductory Note

Based on conversations with Matt Rea of the U.S. Army Corps of Engineers and the June 10th CRT Review listening session, it appears that (1) they have a different interpretation of the term "scenario" and (2) the Entities and Sovereign Review Team are soliciting, modeling, and reviewing what they call "alternatives" to the current management of the river and what Columbia management would look like in 2024 with no action. In regards to this first point, Matt Rea in particular has stated that he feels scenarios are built around a specific decision point rather than the laying out a framework for Columbia Management (and our scenarios are more along the lines of the latter). In regards to the second point, by reframing our scenarios as alternatives our efforts can directly tie into the Treaty review and make the Symposium more appealing to parties participating in the SRT process (attached is the document circulated at the listening session which illustrates where our efforts could complement or inform the Treaty review process). Thus we have adapted some of our "scenarios" into "alternatives" or "alternative approaches." The content did not change only the names by which the documents are called. While this a minor change, making this change will serve to improve communication with those involved with the Treaty review and better meet the needs of the Treaty review process.

Please let us know if you have any questions.

Thank you,
Columbia Treaty Team at OSU

Columbia River Treaty symposium preparation: Alternatives development
June 2011

Alternative management title: Called Upon with Information Sharing Agreement

Theme or summary:

This alternative approach assumes that management of the Columbia River and flood control in 2024 shifts from "assured annual flood control" based on pre-determined annual operations (with pre-paid Canadian storage with the ability to call upon Canada for additional storage) to independent reservoir and river management in the two countries where the US can still call upon Canada for storage after it fully utilizes its own storage space. In this alternative approach there is not international coordination of the river or payment for downstream benefits. This alternative explores regular dam and reservoir operation under this management framework and how the US would utilize the "Called Upon" provision of the Columbia River Treaty that goes into effect in 2024. While dam and reservoir operation will not be pre-determined annually by the two countries, Canada would agree to share its planned operations with the US in order to make the best decisions based on the water expected to cross the border over the course of the next two years. More specifically, Canada would release a two-year operation plan each year (addressing the current and following year) as well as provide updates if the plan is revised at any point. Since the infrastructure is currently in place to monitor all dams along the system in real time the two countries would agree to keep this technology running to inform US dam operations. If Canada fails to share this information it would be required to pay the US for loss of revenue and damages (much like the US would have to pay for damages, operations, and loss of revenue when employing the Called Upon provisions of the Treaty). The information sharing would not require Canada to consult the US on operations only share what decisions were made and what water will be flowing over the border.

Assumptions:

- The Treaty provision that:

  > …for so long as the flows in the Columbia River in Canada continue to contribute to potential flood hazard in the United States of America, Canada shall, when called upon by an entity designated by the United States of America for that purpose, operate within the limits of existing facilities any storage in the Columbia River basin in Canada as the entity requires to meet flood control needs for the duration of the flood control period for which the call is made. (Article IV(3))…is interpreted to mean that Canada operate for additional storage using reservoirs and storage space built prior to 2024 and used in pre-2024 assured annual flood control.

- No additional non-Treaty storage agreements are made between the US and Canada but current non-Treaty storage will continue.

Operations:

Operations under this management approach would be as follows:

- There would be no international coordination of the management of the river only an agreement to share information on how the river will be managed (and thus no payment of Entitlement).

- Canada would operate its dams for its own interests mainly to maximizing power generation, ensuring Canadian flood control, and secondarily to protect its listed species.

- US operations would be coordinated on a national scale except in the case where there are existing non-treaty storage agreements (through which Canada and the US could coordinate operations):

    - US coordination would be based in part on the information sent by Canada on how it planned to operate its dams and reservoirs for the current and subsequent years.

    - Flood control in the US would rely on domestic storage and Called Upon measures.

    - Coordination of all storage space in the US includes private and public reservoirs. This domestic coordination would work to ensure full utilization before initiating the Called Upon process (see agreements for more information).

    - US would operate its dams based on (1) flood control (2) Endangered Species Act requirements and (3) power generation (in that priority order).

    - To ensure flood protection US reservoirs would be drawn down further in the late winter/early spring to accommodate for snow and glacial melt bringing higher flows (this includes Grand Coulee and Brownlee reservoirs drafting toward empty).

- The Treaty provision that:

> For each flood period for which flood control is provided by Canada under Article IV(3), the United States of America shall pay Canada in United States funds: (a) the operating cost incurred by Canada in providing the flood control, and (b) compensation for the economic loss to Canada arising directly from Canada foregoing alternative uses of the storage used to provide the flood control (Article IV(4)(b))…is interpreted to mean that the US must pay for operation of Canadian dams and reservoirs during a "Called Upon" situation as well as for damages and economic losses arising from the operations of the storage space. This payment would be determined by a

jointly chaired and staffed body of Canadians and Americans appointed by their respective agreement signatories (e.g., Department of State in the US).

- Coordination of Libby dam would continue as it is operated now under the Libby Coordination Agreement

Benefits:

No benefit sharing will be done in the basin. Rather benefits, such as flood control, will be paid for by the receiving party. Other benefits include:

- Ability for Canada to operate for increased power generation .
- Continued friendly relations through information sharing operations notice.
- The US would have some sense of what water will be flowing over the border over the next two years.
- Provisions to protect US right to information on how Canada would operate its dams and reservoirs.
- The flood control back up plan of the Treaty "Called Upon" provision, which includes monetary compensation for Canada.

Form of Agreement:

In this alternative approach the Called Upon provisions of the Treaty remain in place (or rather shift from "On Call" to Called Upon); however the pre-paid storage ends, and there is no coordination of river management and no payment of the Canadian Entitlement. Thus, non-Treaty storage and Called Upon remain the only two means of international storage coordination. However, the US and Canada would both sign an agreement dictating an information sharing process by which Canada can inform the US of how it will operate its dams, thus allowing the US to plan its dam operation based on that information. Failure to abide by this agreement and share information would result in a fine to Canada to pay for lost revenue and resulting damage. This information sharing agreement would include a commitment from Canada to share a two year operating plan each year (addressing the current and following year) as well as updates to that plan if Canada makes revisions at any point in the year and real time information of flows at various dams along the river.

An independent review board of both Canadian and US representatives would be charged with 91) determining if the loss of revenue and damage to US was caused by a failure to share information and if that is the case (2) the dollar amounts for those two items. This board could also be utilized to assess loss of revenue and damages incurred in a Called Upon situation.

Within the United States, an agreement would be developed between all private and publicly owned storage in the US to coordinate all domestic storage and develop a plan for flood risk management and other desired benefits. This would include a plan on how the US government could pay for use of private storage it if was needed.

Implementation:

The first step would be to develop the specific provisions of the information sharing agreement, including the penalty for Canada if it fails to share information and the specific process for determining if there was such a failure. The implementation would also require the creation of a board or body to assess the cost of Called Upon and the fine for failing to share information.

A significant fact-finding effort is needed to better understand possible implementation of this alternative approach including:

- Conducting a new Biological Opinion for the new management of the basin to account for increased dependence on US storage.

- Determining what increased fluctuation in reservoir levels means for cultural sites and endangered species protection.

Areas of Uncertainty:

Areas of uncertainty in this alternative approach to managing in the Columbia include:

- The findings of post-Treaty Biological Opinion.

- How the US would balance hydropower production and ESA listings in light of the coordination of storage for flood control and ensuring full utilization of US storage.

- The degree of reservoir fluctuation.

Columbia River Treaty symposium preparation: Alternatives development
June 2011

Alternatives management title: Regional River Governance

Theme or summary:

As an alternative to the continuation of the Columbia River Treaty, this document proposes a new form of governance of the Columbia River with a 'values-based regional approach.' In this approach various regions in the basin are delineated and are governed to accomplish specific goals based on values/benefits identified by those negotiating the agreement(s). Values/benefits can vary from region to region. The size and breakdown of the regions can also vary (i.e., under this governance framework parties will negotiate how to divide the basin into regions based on what benefits they wish to promote). This proposed alternative assumes Treaty termination, allowing for new agreements to layout the governance of the regions. This approach allows for consideration of additional issues or values beyond flood control and hydropower and lists potential values the river could be managed for and potential ways of regionalizing the river. However, parties interested in modeling this alternative would need to take the time to determine the level of regionalization and the specific values they wish to include.

Assumptions:

Assumptions include:

- The Columbia River Treaty is terminated.
- Involved parties will determine what regions to delineate within the basin; the number and size of the regions will be based on the values and benefits (and the combination of those values and benefits) the parties wish to include.
- Subsidiary agreements (sub-agreements) will be developed between parties to coordinate activities to best serve regional interests.
- Canada and the US (or the private companies in the country) will each take over complete ownership and operations of the dams and other infrastructure in their respective countries.

Operations:

The parameters for operations under this alternative management scheme would be:

- Regions of the basin will be governed to accomplish certain goals and to obtain certain benefits.

- Flood control in the US would rely on domestic storage, the 1990 Non-Treaty Storage Agreement, and Called Upon measures unless flood control/flood risk management was identified as the (or one of the) values the region would be managed for.

- In the case where there are existing non-treaty storage agreements Canada and the US coordinate operations according to those agreements.

- Potential values that will dictate operations include, but are not limited to:

    - Canada could operate its dams for its own interests including maximizing power. generation, ensuring Canadian flood control, and protecting its listed species.

    - US could operate its dams based on 1) flood control 2) Endangered Species Act requirements and 3) power generation.

    - Regions could be managed to preserve cultural resources.

    - The undammed portion of the river could be managed for recreation and tourism.

    - Regions could be managed to meet irrigation water and other water supply needs.

    - The lower Columbia and Snake River could be managed for navigation.

- Coordination of river management could occur on multiple levels (depending on the number and size of the regions) and will depend on the development of agreements within and between regions. These sub-agreements could include but are not limited to agreements:

    - Within each nation on a national scale.

    - Between two facilities or parties.

    - Along tributaries or in sub-basins (e.g., parties along the Snake River).

Benefits:

As stated above, governance of the various regions will be governed for one or more benefits. Possible benefits or values which could be used determine river management include:

- Cultural resources
- Fish and wildlife
- Flood control/flood risk management
- Irrigation
- Navigation
- Power generation
- Recreation and tourism

- Water quality
- Water supply
- Other economic interests

Without an overarching treaty or other form of agreement between regions no benefit sharing will be done in the basin. Rather benefits, such as flood control, will be paid for by the receiving party. Other benefits of this alternative approach include:

- Allows for the potential management of the river based on values not considered in the development of the Columbia River Treaty.

- Allows sovereigns and stakeholders to evaluate values and identify desired benefits.

Implementation:

To implement this alternative to the Columbia River Treaty, parties would need to determine how to regionalize the basin (this can range from keeping the basin as one region to any number of smaller regions of various sizes). This will include deciding the values or benefits a particular region will be managed to attain or maximize (this can range from one value to any number of combinations of values). In this management approach of the river, payments to the Canadian Entitlement end and the implementation of any management is done at the regional level, though there may be coordination between regions. Without a formal treaty or overarching agreement the US and Canada would need to find an alternative way to equalize benefits across the international border if desired. A significant fact-finding effort is needed to better understand possible implementation of this alternative approach including:

- Determining what Called Upon means on an operational level (this includes determining what is considered full utilization of US storage).

- Determining the range and timing of river flows as altered by dam operations for the various values and benefits.

- Conducting a new Biological Opinion for a post-Treaty basin.

Form of Agreement:

Sub-agreements would be developed for the regions to operate dams, reservoirs, and other infrastructure on the river. These agreements spell out the goals for the region's management based on the identified values/benefits. These sub-agreements could be created on an international, national, state, sub-basin or local level as well as between the US and Native American Tribes or Canada and the First Nations. For example, privately and federally operated dams in the mid and lower Columbia or facilities along the Snake River could develop an agreement to coordinate dam operations to better meet flood control needs, maximize power generation, and restore ecosystem functions.

Areas of Uncertainty:

Areas of uncertainty include:

- Number, purview, and other details of subsidiary agreements (i.e., agreements will vary depending on the parties involved); potential agreements include Memorandums of Agreement, Memorandums of Understanding, and Annual Operating Procedures.

- The findings of post-Treaty Biological Opinion and how they would impact dam operations and water supply/allocation in the US.

Columbia River Treaty symposium preparation: Alternatives development
June 2011

Alternative Management Title: A River Basin Commission

Theme or Summary:

This alternative proposes a redrafted Columbia River Treaty based off of the current format and concept of the Pacific Salmon Treaty, signed between the U.S. and Canada in 1985. Several stakeholders and sovereigns interviewed in the Columbia River Basin have expressed a desire to see a treaty for the Columbia River based upon this format, in which a river basin commission would be established, charged with implementing the Columbia River Treaty. Specifically, this alternative would establish a commission independent of the entities that currently operate the treaty, which would specifically be charged with implementing the treaty in a flexible and equitable way based upon several factors including water allocation, climate change, fish passage, tribal rights, and a number of other factors. Two specific factors that have been identified by stakeholders and sovereigns that are very effective in the Pacific Salmon Treaty but lacking in the Columbia River Treaty are full representation on the commission and negotiation power of tribal and other sovereign groups, as well as better flexibility by the commission to adapt management plans to climate change and other uncertainties. In summary, while this alternative does not assume treaty termination, it puts forth that a new treaty be negotiated by several groups and interests beyond hydropower and flood protection; and that an independent commission then be established that would include representatives from each interest group that would then be charged with implementing the treaty in a flexible manner.

Assumptions:

Assumptions of this alternative include:

- The Columbia River Treaty is renegotiated to reflect evolving values within the basin and with flexibility in mind.
- Involved parties will establish a river basin commission to implement the treaty.
- The commission will include voting members from Canadian and U.S. federal, state, and local agencies as well as tribal sovereign governments.
- Current treaty dams will be operated in a manner to be determined by the commission that will bring the greatest benefits to all the parties involved, i.e. hydropower and flood protection may not always be prioritized.

Operations:

The parameters for operations under this alternative would be:

- The basin will be governed by a treaty meant to represent the different interests throughout the basin as a whole, with no definite prioritizing of one interest such as hydropower over another represented within the words of the treaty.

- Flood control measures as referenced in the current treaty would go to the Called Upon scenario of 2024, and be utilized in an adaptive manner by the commission in weighing flood control against other needs, the specifics of called upon would be defined by commission.

- Hydropower and flood control would both be managed in a equal basis with fish passage, ecosystem health, and other needs as determined and voted on by the commission.

- Other non-treaty flood control and hydropower measures would be evaluated by the commission on a case by case basis and recommendations would be made for how to best manage these agreement in accordance with the new treaty operations.

- Potential values that will dictate operations include, but are not limited to:

    - Hydropower
    - Flood Protection
    - Ecosystem Function
    - Endangered Species Act and fish passage needs
    - Tribal interests
    - Water quality
    - Water supply
    - Transportation
    - Recreation
    - Cultural Resources
    - Other economic interests

- Coordination of river management and treaty implementation as dictated by the commission would occur through several federal, state, and local agencies beyond the current three federal entities

Benefits:

As stated above the primary benefit is that the basin will be governed as one continuous unit in a flexible manner, with no given preference in the treaty language for one use or value over another. Benefits will be allocated in an equitable manner as determined by the commission. Such decisions will be voted on the by the commission who will decide under each given circumstance how to best meet the needs of each stakeholder as well as the basin as a whole. This will allow all stakeholders to at least feel as if their voices have been considered and allow greater flexibility in a future of uncertainty with regards to climate change, water storage, salmon survival, etc.

Costs:

The treaty language will not include any specific methods or language for operations or implementation, as this will be in the hands of the commission. Therefore the one real cost is that the commission must be relied on to make any specific decisions regarding the management of the river. Thus, while this alternative is designed to deal with uncertainty and to provide flexibility, in doing so it also contains uncertainty itself.

Implementation:

To implement this alternative parties in Canada and the U.S. would have to come to a consensus that more values within the basin beyond hydropower and flood protection must be recognized as paramount. Flood protection would have to be moved into the called upon alternative of 2024 so that it would not be a continuous part of operations as it currently is, as this could interfere with other needs of the river. This new called upon would be specifically defined by the commission on a rolling basis. Furthermore in redrafting the Columbia River Treaty, an agreement would have to be reached as to what groups and governments would each be represented within the new river basin commission. Under the Pacific Salmon Treaty, the groups represented from both the Canadian and U.S. on the commission include federal, state, and local governments, as well as tribal governments. At the current time, selected stakeholders interviewed within the basin feel that this is an adequate form of representation.

Form of Agreement:

Each of the state departments of the two countries would agree upon a flexible treaty whose implementation would be placed in the hands of the river basin commission. As stated, this commission would include members representing different levels of stakeholders and sovereigns throughout the basin, to better include the interests of the river as a whole. The treaty would be flexible in the sense that it would lay out specific goals and values that would be considered important in the basin's management, but would leave the implementation of these goals and values up to the designated commission.

Areas of Uncertainty:

Areas of uncertainty in this alternative include:

- Specific values and goals that need to be included in a new treaty need to be more clearly identified though public processes, such as the current sovereign and non-sovereign stakeholder meetings being held I the U.S., and the University sponsored symposia. These could also be identified through more extensive basin wide research in both the U.S. and Canada.

- The willingness of the federal entities in both countries to agree to such a broad in scope situation in which they would effectively lose management control over potions of the basin to a commission would need to be addressed.

Columbia River Treaty symposium preparation: Alternatives development
June 2011

Alternative Management Title: Planning for the Potential of Low Flows in the Columbia River Basin

Theme or Summary:

This alternative takes into account the instance that the Columbia River would have low flows. It assumes that the United States and Canada will have agreed upon a plan with which to handle the unintended consequences of low flows in the Columbia River. The basin as a whole is predicted to get warmer, while precipitation will stay fairly constant. However, the timing of snowmelt will change. Winter snow accumulation will reduce, shifting summer streamflow to the winter. These shifts in the seasonality of inflows to the Columbia River Basin's reservoir system has been found to reduce the reliability of spring and summer non-firm energy production, irrigation, summer instream flow targets, and summer recreation purposes (Payne et al. 2004).

Assumptions:

The Columbia River Treaty continues as is, based upon its original intentions: hydropower and flood control. Climate change continues, warming the Columbia River basin to the point that its annual hydrologic flow patterns are altered. The nations agree on adding a section in the treaty regarding low flows.

Benefits:

Building a plan to address how the United States and Canada will address low flows will allow both nations to plan for such side effects as lower hydropower revenues. Dam operators would be able to lower their firm power (power that is able to be produced under the most extreme drought conditions) according to the severity of the drought.

Costs:

Having low flows in the Columbia River mainstem could have severe economic consequences, from lowered hydropower production and revenue to a decrease in the fish population. In this situation, hydropower production may have to be sacrificed to allow for the fish population to rebound.

Implementation:

The plan would go into effect depending on the severity of the hydrological drought. It would be effective after the signing of the renewal of the treaty. Adaptations that will have to be made include taking into account the following areas:

- Hydropower
- Storage
- Fish
- Irrigation

Reallocation of firm hydropower production can be changed from winter demands to summer months, as warmer winter temperatures and summer temperatures will lower the demand in the winter and raise the demand in the summer. Reservoir storage locations will have to be increase to fulfill environmental targets.

The key for the treaty's success will be an inherent flexibility built into the framework of the treaty.

Form of Agreement: An agreement is signed between all sovereigns following the renewal of the treaty.

Areas of Uncertainty:

It is still unclear how much the hydrologic regime will change. Variables such as peak flow, total volumetric flow, and temperature may all vary depending on the time of year, the amount of warming, and the hydrologic deficit.

Reference:

Payne, J.T., A.W. Wood, A.F. Hamlet, R.N. Palmer and D.P. Lettenmaier. 2004. Mitigating the effects of climate change on the water resources of the Columbia River Basin. Climatic Change 62: 233-256.

Columbia River Treaty symposium preparation: Alternatives development
June 2011

Alternative Management Title: Establish the Columbia River Basin as an "international commons"

Theme or Summary:

This alternative would change the Columbia River into an "international commons," shifting the river into something beyond the legal jurisdiction of sovereign states. This alternative removes the question of sovereignty within the mainstem of the Columbia River. It allows for the opportunity for a multi-sovereign (including Native American Tribes) organization, such as the International Joint Commission, to create a sub-organization (for this alternative, entitled the Columbia River Commission) whose sole purpose is to manage the Columbia River. Like the International Joint Commission, each nation could appoint an equal number of voting members, representing the interests of various stakeholders, who get to be in charge of deciding how the river is managed. This would be an example of "collaborative ecosystem governance," where state, sub-national, and non-state actors actively collaborate in the construction of provisional solutions, and devise adaptive learning and management strategies that have flexibility to adapt to new environmental measures and regulatory conditions (Karkkinen 2005). These efforts would be similar in structure to ecosystem management strategies for the Baltic Sea and Chesapeake Bay.

Assumptions:

The Columbia River Treaty is terminated, with Called Upon flood control measures still in effect.

Operations:

Control of the river is handed over to the Columbia River Commission. All concerns, whether environmental, ecological, navigational, etc., are addressed through the Commission. Organizations such as the Bonneville Power Association, the Army Corps of Engineers and BC Hydro would be operated in the same manner as the present, but would have to have any operational changes approved by the Commission.

Benefits:

The ecological concerns would be easier to address. The Columbia River Commission could act as a single unit to address any environmental issues.

By placing authority under this Columbia River Commission, the question of negotiating between these two countries would be removed as both countries would have to send their requests through the Columbia River Commission.

Hydropower revenues could be solely used to better the Columbia River. Whether this means that the revenues would be used to restore the salmon population, improve navigation, improve recreational areas, increase hydropower production, etc. would be determined by the Columbia River Commission.

Stakeholders could have the opportunity to more directly voice their concerns, as the Columbia River Commission's membership would consist of their peers instead of government bureaucrats.

Costs:

The change of authority could sour relations between the stakeholders and the commission, as some stakeholders may be reluctant to have their decision-making powers rescinded.

Implementation:

Transfer management of the dams to the International Joint Commission. Flood control ends with the exception of Called Upon.

Form of Agreement:

An agreement is signed between all sovereigns giving the Columbia River Commission central authority in all matters related to the Columbia River Basin.

Areas of Uncertainty:

The role of how the dams (both with the purposes of flood control and hydropower) would be undetermined. Also, it is unclear how far the international commons would extend. There is a possibility that it could include the groundwater connected to the basin.

Each sovereign could conceivably be unhappy with the Columbia River Commission's allocations and focuses. Either country might not be willing to part with the power (both hydroelectrically and generally) associated with various aspects of the river.

Reference:

Karkkainen, B.C. 2005. Transboundary Ecosystems Governance: Beyond Sovereignty?. In: C. Bruch, L. Jansky, M. Nakayama and K.A. Salewicz, eds. Public Participation in the Governance of International Freshwater Resources. Tokyo: United Nations University Press, 73-87.

Columbia River Treaty 2014-2024 Review

Stakeholder Listening Session

March 10, 2011; 1:00-4:00 p.m.

Portland, Oregon

SUMMARY OF SESSION DISCUSSIONS

Overview

Under the Columbia River Treaty, Canada and the United States jointly manage the Columbia River for power generation and flood control as it flows from British Columbia into the United States. The United States (U.S.) Entity, designated to implement the Treaty for the U.S., is comprised of the Administrator of the Bonneville Power Administration as Chairman and the Division Engineer of the U.S. Army Corps of Engineers Northwestern Division as Member.

The U.S. Entity is currently in the process of conducting a review to evaluate the future of the Columbia River Treaty after 2024. The Columbia River Treaty 2014/2024 Review (Treaty Review) establishes a framework for interested parties to collaborate with the U.S. Entity as it studies and evaluates alternatives needed to better understand the implications of post-2024 Treaty alternatives. By late 2013, the U.S. Entity will make a recommendation to the U.S. Department of State on whether it is in the best interest of the U.S. to continue, terminate, or seek to amend the Treaty.

The Treaty Review Sovereign Participation Process establishes a framework for sovereign parties to collaborate and coordinate with the U.S. Entity in the process of conducting technical studies and evaluating alternatives needed to better understand potential Treaty futures. A broader group of regional stakeholders (outside of the sovereigns) will be invited to regularly participate in both the formation and analysis of the alternatives.

On March 10, 2011, the U.S. Entity sponsored a half- day "listening session" to hear from regional stakeholders about their interests and desired outcomes for the Treaty Review. Approximately 60 stakeholders representing a wide variety of interest groups attended the session.

Steve Oliver from the Bonneville Power Administration (BPA) and Witt Anderson from the U.S. Army Corps of Engineers (USACE) serve as Coordinators for the U.S. Entity and jointly oversee the Treaty Review process. Jim Barton (Chief, Columbia Basin Water Management Division, USACE) sat in for Witt Anderson during the listening session.

Structure for the Meeting

The listening session was preceded in the morning with a Treaty overview presentation from Nancy Stephan (Treaty Review Program Manager, Bonneville Power Administration) and Matt Rea (Treaty Review Program Manager, U.S. Army Corps of Engineers). A copy of their

Powerpoint presentation is posted on the Treaty Review website at http://www.crt2014-2024review.gov/.

In the afternoon, Jim Barton and Matt Rea outlined the process that has been established for the regional sovereigns and stakeholder to participate in the Treaty Review. Part of this process includes the formation of a Sovereign Review Team (SRT). The "sovereigns" participating on the team include representatives from the states of Oregon, Washington, Idaho and Montana, 15 Northwest Tribes (5 Representatives on the Sovereign Review Team), National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, Bonneville Power Administration, Bureau of Land Management, Environmental Protection Agency, U.S. Forest Service, U.S. Geological Service, Bureau of Indian Affairs, and National Park Service.

The SRT meets monthly to review and discuss policy-related issues. The SRT is ultimately responsible to deliver a recommendation to the U.S. Entity regarding the future of the Treaty. Providing technical, modeling, and analytical support to the SRT is the Sovereign Technical Team (STT). The STT is made up of technical representatives from the same organizations and entities participating on the SRT. It is the responsibility of this team to organize and review the technical studies and data that will inform the SRT.

After the introductory presentation, participants divided into eight interest-based discussion groups, which included: Ecosystem-Based Function, Fish and Wildlife; Ecosystem-Based Function, Cultural Resources; Ecosystem-Based Function, Water Quality; Hydropower; Navigation; Water Supply; Flood Risk; and Irrigation.

Each of the discussion groups were asked to share their "desired outcomes" for the Treaty Review process, as well as obstacles they could see to a successful Treaty Review, and any concerns they might have about the Review process.

DISCUSSION RESULTS

Common Themes

Regardless of the interest-based topic under discussion, all of the groups shared some common themes. The common discussion themes are summarized below into the two categories that emerged: process and technical.

Process Comments

- All of the discussion groups asked about the overall sovereign/stakeholder process. They had questions about the level of involvement from regional stakeholders. They asked that the process be fully transparent, and they requested that the non-sovereign stakeholders be allowed to fully participate in the scoping, metrics, and methodologies associated with those studies. They asked that stakeholders be able to observe the analysis conducted as part of the Treaty Review, and understand the outcomes that are meaningful to the varied interests throughout the region.

- Those attending also wanted clarity on the schedule for the process, as well as their ability and timing to have direct influence on the U.S. Entity. Where is our opportunity to assist the Entity in its recommendation to the U.S. State Department?

- Some of those attending expressed concern about hydropower, flood control, navigation and irrigation interests being represented on the Sovereign Review Team. They noted that Steve Oliver and Witt Anderson were also representing the U.S. Entity and serving as co-chairs of the SRT, and wondered if their interests would be fully represented with Steve and Witt wearing multiple hats. They want to make sure everyone is heard as the process unfolds.

- Several groups expressed concern about the geographic scope of the study area, and were concerned that it might be difficult for all interests to be fairly represented, given the number of issues and stakeholders involved. How can all of these be accounted for, and their opinions used to influence the process?

- Numerous questions were raised regarding the schedule for Treaty Review, with concerns raised about the relatively short timeframe (end of 2013) by which a recommendation is due to the U.S. State Department.

- A number of attendees asked questions about Canada's interests in the Treaty Review process, and wondered what Canada's position might be regarding the treaty parameters. One question, for example, was the degree to which Canada would be willing to discuss and/or negotiate on environmental issues.

Technical Comments

- Although the listening session was structured around a range of stakeholder interests, those attending the session also suggested a number of "bigger questions" that should be addressed through the study process. These framework questions, they felt, would then help to focus the individual study areas. Participants identified these larger questions: Does the existing treaty fundamentally make sense for our region? What are the benefits of the current treaty? What is it costing us now? What happens if the treaty goes away? With no treaty in place, how will our flood risk and other responsibilities change, and what will those costs be? What about issues outside of flood risk management and hydropower? How are those accounted for under the current Treaty, and what might be changed in those areas if the Treaty is changed?

- Regardless of the subject area, each of the groups expressed concerns about how the studies would be conducted: what existing information will be used; what are the parameters for the studies; what are the metrics?

- All of the groups acknowledged the importance of balancing their interests with the other interests in the room. Environmental advocates recognized the importance of hydropower and flood risk management. Hydropower and irrigation interests acknowledged the importance of fisheries and habitat protection. Flood risk and navigation representatives

also described the importance of achieving balance between all of the interests in the Treaty Review process.

- There were a number of questions about the way in which study information would be funneled into, and used by the SRT and STT as their recommendations are developed.

- The groups had questions about the way in which existing data and studies would be used, and the process for getting that information into the hands of the Sovereign Review Team and Sovereign Technical Team.

- The "called upon" provision of the Treaty means that, after 2024, Canada will be obligated to provide flood control only when "called upon" and only after the U.S. has exhausted all of its own flood control mechanisms. This was of concern to all of the discussion groups, with participants believing that this provision inserts a number of significant "unknowns" regarding the way in which the Columbia River will be operated in the future.

SUBJECT MATTER DISCUSSIONS

In addition to the common themes highlighted above, each of the discussion groups shared desired outcomes, questions, and concerns related to their specific subject matter:

Ecosystem-Based Function: Fish and Wildlife

- This group expressed concerns with the physical limitation of the system, noting that both the U.S. and Canada "can only spill so much." They also recognized that there are many competing interests in the Treaty Review process, as well as a number of unknowns. This group asked: What is the universe of possibilities for ecosystem improvements and how does the Treaty work with U.S. operations and other U.S. ecosystem opportunities?

- This discussion group urged a maximum level of system flexibility in order to balance hydropower and flood risk needs with fish and wildlife habitats. There were concerns expressed about the effects of the treaty on the bull trout population. And, this group noted that there is an inventory of past work and efforts to build on as part of the Treaty Review.

Ecosystem Based Function: Cultural Resources

- This discussion group acknowledged that it is difficult to assess the impacts of the Treaty on cultural resources if there is not an inventory of what is currently available. Many of these cultural resources are not public knowledge. It is important to determine what types of impacts there may be on these resources.

- Regulations and restrictions that protect cultural resources must be fully represented in any modeling work. The group had questions about the criteria that will be used to determine the value or detriment to both fish populations and cultural resources.

Participants noted that currently there is not widespread agreement among stakeholders/sovereigns on either these criteria or the modeling.

Flood Risk Management

- Participants in this discussion group said that a desired outcome for them in the Treaty Review would be a common agreement on the need for an integrated approach for analyzing and managing flood risk. They acknowledged that flood risk has to be balanced with other river functions such as irrigation, further noting that existing obligations for irrigation and water rights must be honored.

- The group urged that existing information be used wherever possible, for example, the Corps of Engineers work in the Tri-Cities. They felt it was important for resiliency to be built into the system. And, as the alternatives are analyzed, the group asked that the technical work fully describe both the monetary and operational shifts that could be anticipated under each of the alternatives/scenarios.

Irrigation

- Those attendees representing irrigation interests expressed concern about future uncertainties. They wanted assurances for irrigation supply, and also wondered if there might be additional storage opportunities (leasing or buying more space) in Canada or elsewhere. They wanted to make sure that future Treaty negotiations would not result in any adverse effects to the Bureau of Reclamation's water rights and to all of the certified water rights associated with the Columbia River Basin.

- This discussion group said they hope the upcoming studies will result in a full and accurate analysis of the costs associated with the Treaty, the water supply available, pumping reliability, reservoir elevations, and the inclusion of Banks Lake reservoir data, which is not currently part of the model.

- When discussing possible obstacles to a successful Treaty Review process, the irrigation group noted that changes to flood risk management could negatively impact irrigation, and that politics might play a role in decisions. They also wanted to make sure that the wisdom and knowledge from the Bureau of Reclamation is fully and meaningfully used by the Sovereign Review Team.

Water Supply

- When describing their desired outcomes, the participants in this discussion group said that they wanted to know, and improve upon, the "shape" of water supply delivery. They wanted clarity on the availability of water above and beyond the current Treaty uses of flood control and hydropower. They want to explore if there is a more optimal use of water resources, and whether or not there are limits to the water supply being shaped differently. This group also wanted to ensure that there is an equitable distribution of water to the United States and various stakeholders.

- This group discussed a number of technical details, noting that it is important to ensure effective data collection and monitoring of snowpacks, for example. They are looking for models with better granularity (daily or even hourly time-steps), and hope to identify target flows within the general capacity of the system.

- These attendees felt it was important to establish a drought strategy for management of the Columbia River system. They also wondered how power benefits might best be optimized – that is, the same or more power production out of the current amount of water available. These stakeholders said that one of their desired outcomes would include an analysis of the highest and lowest flows that would be sustainable in each season of the year, to develop a baseline flow pattern that would best distribute the water.

- The potential impacts of climate change were discussed extensively by this group. They wanted to make sure it is fully accounted for in any future modeling and analysis. They wanted to answer this question: Is climate change an excuse to build more storage? And, they want to make sure the system is flexible enough to change existing reservoir operations to respond to climate change impacts.

Hydropower

- Hydropower interests at the listening session asked that the numbers and data used for the evaluation of alternatives (economics and physical impacts, for example) be both transparent and consistent. Particularly important for this group is the fact that the Mid-Columbia utilities currently pays 30% of the Canadian entitlement, further emphasizing their strong desire for full transparency in the Treaty Review process.

- Cost was another significant issue for this group, with stakeholders asking for a comprehensive cost/benefit analysis of the current Treaty and entitlements, as well as a thorough analysis of the costs that would be incurred without the Treaty.

- The impacts to fish were another issue of concern. Not only did the two hydropower discussion groups indicate a need to balance the needs of fish with power production; they also noted that extensive investments in fisheries habitats had already been made, and they do not want to see these investments downgraded in the future.

- As with other groups, hydropower interests want to make sure climate change is addressed in the process. They also believe there could be opportunities to improve the transmission system as the treaty is reviewed.

Navigation

- Navigation interests at the session emphasized that navigation is protected by the United States Constitution, and that a portion of the Columbia River is a congressionally-authorized navigation channel. This should be viewed as a constraint on the upcoming studies, and cannot be taken away by the U.S. Department of State. Columbia River navigation provides both economic and environmental benefits to the region as a whole.

NEXT STEPS

This summary of the listening session will be distributed to all of those who attended the meeting. The Sovereign Review Team and Technical Team members attended the session and benefited by the direct and extensive level of engagement and comment from stakeholders.

The results of this session will be used to inform the work of the Review and Technical teams as they embark on their work. Additional meetings and sessions for stakeholders will be conducted throughout the Treaty Review process.

Capitalizing on Uncertainty: Development of Alternatives for Regional Dialogues of the Columbia River Treaty

Brendan Galipeau,[1] Kim Ogren,[2] Jacob Petersen-Perlman[3]

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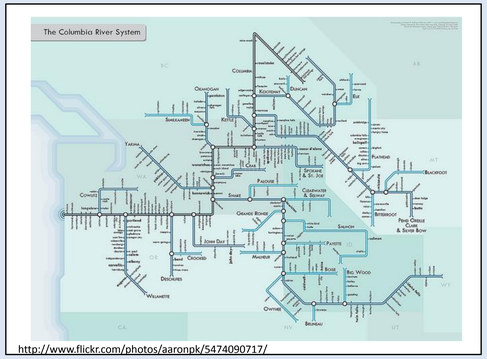
Introduction

The Columbia River Treaty was originally drafted and signed in 1961 with full ratification occurring by both the U.S. and Canada in 1964. The original Treaty was created with two primary benefits in mind: hydropower and flood control. Since that time many other values and benefits have either emerged or have been further expressed by various sovereigns and stakeholders regarding the river. Additionally, various groups such as tribal sovereigns, fishermen, recreationists, power utilities, environmental NGO's etc., are also expressing an interest in playing a role in a possible reworking of the Treaty, as some of its flood control provisions will expire in 2024. Beginning in 2014, either country involved may also give a ten-year notice of intent to withdraw from or make changes to the Treaty.

The Universities Consortium on Columbia Basin Governance is hosting a series of symposia each year leading up to 2014 to engage and involve different stakeholders and sovereigns in discussions about the Treaty and management of the river basin. The next symposium, slated to take place in British Columbia in September of 2011, will involve the discussion of potential possible futures for the river based on various management schemes prepared by graduate students from Oregon State University and The University of Idaho. The plan is to then facilitate stakeholder dialogues using the alternatives in the discussion of the future of the Columbia River basin. These alternatives to the Treaty will also be presented to various stakeholder and sovereign groups as well as at the Pacific Northwest Region Economic Conference in Portland, Oregon in July 2011. In preparation for the symposium, graduate students at these two universities have been conducting background research and interviews with different stakeholder and sovereign groups. We have been seeking to learn both about what aspects of the Columbia River might be included in a new governance framework, and what might be included in a new treaty, if one were to be developed. This poster outlines the research and development process for these alternatives.



http://www.flickr.com/photos/aaronpk/5474090717/

Literature review: Development and Use of Scenarios*

*Scenarios is the term used in the literature and thus is referenced as such in this section. However, we use the term alternative to be consistent with the US review of the Treaty. While the terms are not completely inter-changeable, lessons pulled from the literature on scenarios can be applied to our alternatives.

Scenarios emerged as a methodology for strategic management in the late 1940s. The defining property of a scenario is that it projects a concrete narrative description of an activity that the user engages in order to understand the sequence of steps (i.e., the process) and the projected outcome (i.e., potential futures). Thus scenarios needs sufficient details so that users can infer and understand its design (Carroll 1997, p. 385). A scenario must satisfy a specific goal, occur within a context and require the availability of certain resources, and the participation of one or multiple actors. The context is described detailing a geographical location, a temporal location, and other conditions. Scenarios can also help remedy the most serious obstacle in the design of a plan, which is the chronic lack of knowledge of the application domain (Dzida and Freitag 1998).

Scenarios have also been crafted in planning efforts for water resources management. Diamond (2005) defines environmental scenarios as encompassing future environmental factors and conditions that consist of threats to natural ecosystems and socio-ecological systems, and have consequences towards land use. Water resources scenarios can be used as forecasting tools for water allocation by highlighting water's importance in human survival, ecosystems management, economic activities, agriculture, power generation, and various other industries (Mahmoud et al. 2009). Chenoweth and Wehrmeyer (2006) developed scenarios to compare available water resources in the Israeli/Palestinian water sector. The scenarios identified the future water situations in the sector using the upper and lower bounds of the future population of Israel/Palestine in 2050, together with the most probable population. From these scenarios, they were able to forecast how to manage water in the most effective manner.

Gough et al. (1995) studied the development of scenarios and identified two steps. First, scenario headings and brief descriptions were generated, modified, and reviewed to ensure that the full usage of the system was captured. Second, scenarios were refined, written in natural language, and reviewed by others. Scenarios should be simply constructed. The simpler they are – and the simpler the process used to derive them – the more effective they may be, in part because users are able to understand how they work (Mercer 2003).

Diagram of "Alternatives" Development Process

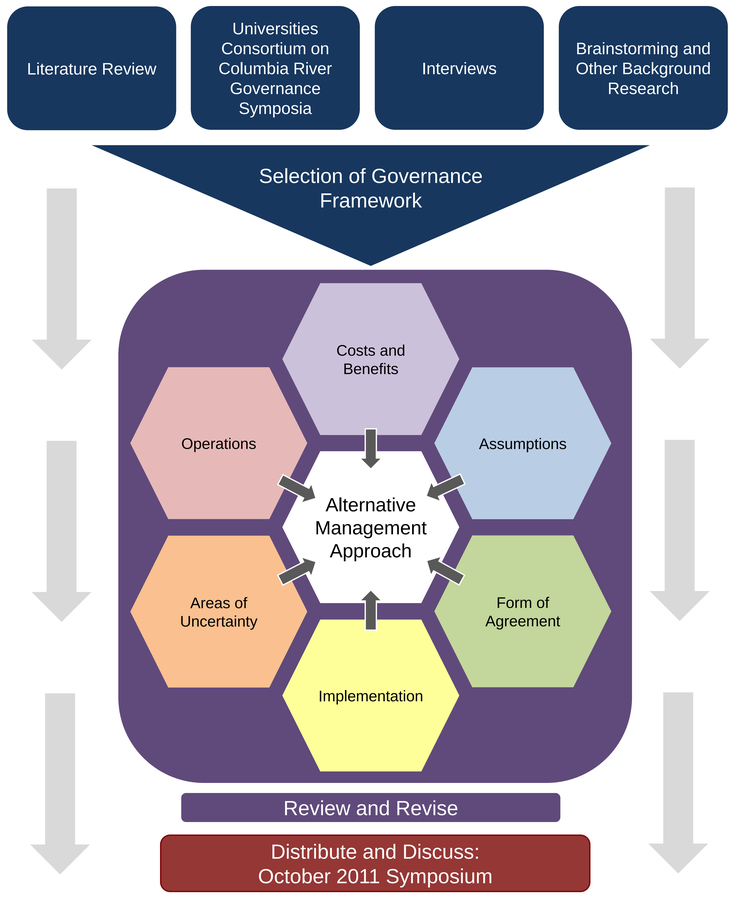


Diagram Explanation

The diagram above represents the process of developing alternative management schemes for the Columbia River employed by Oregon State University graduate students. The process involves three main stages: 1) theme and knowledge gap identification (green), 2) drafting of the alternative approaches (blue), and 3) the discussion of the alternatives in regional dialogues and planning (purple).

Alternative Management Approach Titles

A River Basin Commission

Establishing the Columbia River Basin as an "international commons"

Independent River Management with an Information Sharing Agreement

Planning for the Potential of Low Flows in the Columbia River Basin

Regional River Governance

Universities Consortium on Columbia River Governance

University of Idaho · University of Calgary · Climate Impacts Group · UBC · The University of Montana · OSU

Example Alternative Approach: Regional River Governance

Scenario Summary. As an alternative to the continuation of the Columbia River Treaty, this document proposes a new form of governance of the Columbia River with a 'values-based regional approach.' In this approach various regions in the basin are delineated and are governed to accomplish specific goals based on values/benefits identified by those negotiating the agreement(s). Values/benefits can vary from region to region. The size and breakdown of the regions can also vary (i.e., under this governance framework parties will negotiate how to divide the basin into regions based on what benefits they wish to promote). This proposed alternative assumes Treaty termination, allowing for new agreements to layout the governance of the regions. This approach allows for consideration of additional issues or values beyond flood control and hydropower and lists potential values the river could be managed for and potential ways of regionalizing the river. However, parties interested in modeling this alternative would need to take the time to determine the level of regionalization and the specific values they wish to include.

Operations.

- Regions of the basin will be governed to accomplish certain goals and to obtain certain benefits
- Flood control in the US would rely on domestic storage, the 1990 Non-Treaty Storage Agreement, and Called Upon measures unless flood control/flood risk management was identified as the (or one of the) values the region would be managed for
- Where there are existing non-treaty storage agreements Canada and the US coordinate operations according to those agreements
- Potential values that could dictate operations include, but are not limited to:
  - Canadian dam operation based solely on Canadian interests including maximizing power generation, ensuring Canadian flood control, and protecting listed species
  - US dam operation based on 1) flood control 2) Endangered Species Act requirements and 3) power generation
  - Preservation of cultural resources
  - Recreation and tourism on the undammed portion of the river
  - Meet irrigation water and other water supply needs
  - Manage the lower Columbia and Snake River based on navigation
- Coordination of river management could occur on multiple levels (depending on the number and size of the regions) and will depend on the development of agreements within and between regions. These sub-agreements could include but are not limited to agreements:
  - Within each nation on a national scale
  - Between two facilities or parties
  - Along tributaries or in sub-basins (e.g., parties along the Snake River)

Benefits.

Possible benefits or values which could be used determine river management include:

- Cultural resources
- Fish and wildlife
- Flood control
- Irrigation
- Navigation
- Power generation
- Recreation and tourism
- Water quality
- Water supply
- Other economic interests

Areas of Uncertainty.

- Number, purview, and other details of subsidiary agreements (i.e., agreements will vary depending on the parties involved); potential agreements include Memorandums of Agreement, Memorandums of Understanding, and Annual Operating Procedures
- The findings of post-Treaty Biological Opinion and how they would impact dam operations and water supply/allocation in the US

Assumptions.

- The Columbia River Treaty is terminated
- Involved parties will determine what regions to delineate within the basin; the number and size of the regions will be based on the values and benefits (and the combination of those values and benefits) the parties wish to include
- Subsidiary agreements (sub-agreements) will be developed between parties to coordinate activities to best serve regional interests
- Canada and the US (or the private companies in the country) will each take over complete ownership and operations of the dams and other infrastructure in their respective countries

Form of Agreement.

Sub-agreements would be developed for the regions to operate dams, reservoirs, and other infrastructure on the river. These agreements spell out the goals for the region's management based on the identified values/benefits. These sub-agreements could be created on an international, national, state, sub-basin or local level as well as between the US and Native American Tribes or Canada and the First Nations. For example, privately and federally operated dams in the mid and lower Columbia or facilities along the Snake River could develop an agreement to coordinate dam operations to better meet flood control needs, maximize power generation, and restore ecosystem functions

Implementation.

To implement this alternative parties would need to determine how to regionalize the basin (this can range from keeping the basin as one region to any number of smaller regions of various sizes). This will include deciding the values or benefits a particular region will be managed to attain or maximize (this can range from one value to any number of combinations of values). In this management approach, payments to the Canadian Entitlement end and the implementation of any management is done at the regional level, though there may be coordination between regions. Without a formal treaty or overarching agreement the US and Canada would need to find an alternative way to equalize benefits across the international border if desired. A significant fact-finding effort is needed to better understand possible implementation including:

- Determining what Called Upon means on an operational level (this includes determining what is considered full utilization of US storage)
- Determining the range and timing of river flows as altered by dam operations for the various values and benefits
- Conducting a new Biological Opinion for a post-Treaty basin

Going Green One Little Baby Step at a Time: Transforming Modern Power Production through Microscale Hydropower

W. Todd Jarvis[1], Kendra Sharp[1], Jennifer A. Holderman[2], and Bryan Cobb[1]

[1]Oregon State University, [2]Lower Nehalem Watershed Council

Introduction

One often hears of the lack of access to clean water and sanitation when it comes to disadvantaged countries. Consider that modern global energy access leaves 1.4 to 1.6 billion people live without electricity, and an additional one billion people have access only to unreliable sources of electricity. Three billion people rely on solid fuel (coal, wood, and other biomass). Approximately 80% live in rural areas. Like water and sanitation, the UN Millennium Development Goals target universal access to modern forms of energy by 2030. Like water and sanitation, the estimated costs to achieve this goal are modest totaling $36 billion per year.

Microscale hydropower, facilities that produce between 1 kW and 1 MW of power, has the potential to revolutionize modern power production with little impact on the environment. Microscale hydropower technology is available and robust, but the initial expense can be a significant obstacle to entry in the sector. These limitations can lead to projects that are not financially feasible. Additionally small water resources tend to be ungauged; understanding power production feasibility requires straightforward ways to estimate flow. These water resources are typically very intermittent. Consequently technology and infrastructure must be designed to optimize year round power production.

Few case studies exist on evaluating the feasibility of sites for microscale power. This Oregon case study examines the legal, policy, science and engineering questions that need to be considered in the development of a microscale hydropower facility. This case study reveals that small water resources can be developed as viable and economically feasible sources for residential use. For these resources to contribute clean and green power to the grid, the great potential of microscale hydropower must be recognized. Legal and policy reforms along with new technologic innovations can address these limitations and support wide scale application.

Micro-hydro in the Oregon News…

OregonBusiness

Championing micro-hydro development

The Latest

Thursday, March 31, 2011

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By Peter Beland

The Hydropower Improvement Act of 2011 (S. 629) was introduced last week by Energy and Natural Resources Committee Ranking Member Lisa Murkowski (R-AK) and co-sponsored by Sen. Ron Wyden (D-OR). The legislation could help the development of conduit hydropower throughout the state. Conduits, or canals and other man made structures that transport water for municipal, agricultural or industrial purposes but not for hydroelectric power production, are found throughout the state and represent an untapped power source to many.

Jed Jorgenson of the Oregon Energy Trust has been working for the past three years with water stakeholders connected with the networks of Portland General Electric and Pacific Power to help micro-hydro power development. Though the energy trust can help qualified projects with initial costs, the number of projects that get off the ground is small in part because of high permitting fees. "A small project has to go through the same permitting as large project," says Jorgenson. "The way it is now, it costs [at least] $20,000 to permit a 5-megawatt hydro project and $20,000 to permit a 5-kilowatt one." The Federal Energy Regulatory Commission puts small-scale projects that could power ranches in the same category as larger projects.

If the legislation were enacted later this session, it would call for three regional stakeholder meetings throughout the country to discuss how to reduce permitting barriers and put conduit hydropower into its own category to exempt it from disproportionate regulation. Enterprise-based energy consulting firm Renewable Energy Solutions released a report last November stating that 19 conduits it studied in Wallowa County could produce one megawatt of energy, worth $244,000 annually.

Rural areas are not the only locations for conduit hydropower development. The water traveling through municipal pipes travels quickly and builds up pressure, energy that usually is released to make sure pipes don't burst by pressure reduction valves. The City of Astoria is currently developing an urban conduit hydropower system to capture 37 kilowatts of energy through turbines in the city's pipes. The energy produced would offset the annual electricity cost to run the city's wastewater treatment center.

Astoria special projects consultant Mike Morgan is happy that project should be running by early fall, but laments that "We're putting $25,000 [in FERC permitting fees] into a pre-existing pie. That seems excessive to me. Unless you're sucking water out of a salmon stream, I think micro-hydro should be automatically exempt."

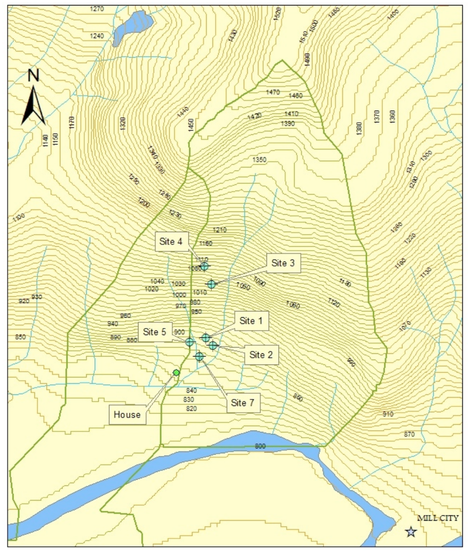
Peter Beland is a contributing writer for *Oregon Business*.

Acknowledgement of Investors

The authors express sincere appreciation to the Rada family for their monetary and in-kind contribution, without which this project would have never been realized and executed. From the beginning the family has recognized the importance of innovations in the renewable energy sector and the importance of small scale projects to this end. To achieve wide scale distributed energy production, many small scale case studies must pave the way. Additionally the Rada family wishes to honor their husband and father, Dr. Edward L. Rada, a long-time Mill City resident and alumni of Oregon State University who recognized the value of water as a potential source for power generation.

Research on Site Evaluation and Equipment Installation

Organizations that promote green energy, such as the Energy Trust of Oregon, respond to citizen inquiries about the suitability of a site for microhydro power generation as either (1) the site may be in a "protected area" of certain reaches of a river where hydroelectric developments are prohibited or restricted by Northwest Power and Conservation because of unacceptable risks to fish and wildlife, and (2) a simple relationship between the measured head and the amount of water flow in the creek. Few case studies exist regarding site specific evaluations of the suitability of a site for micro-hydro. Likewise, few studies have evaluated the performance of turbines used for micro-hydro power generation under different types of routine installation scenarios such as "homemade" versus manufactured jets and jet installation. This study was undertaken to evaluate a site strictly from a hydrogeologic and mechanical engineering perspective to build upon the knowledge base to better evaluate sites under consideration for micro-hydro.



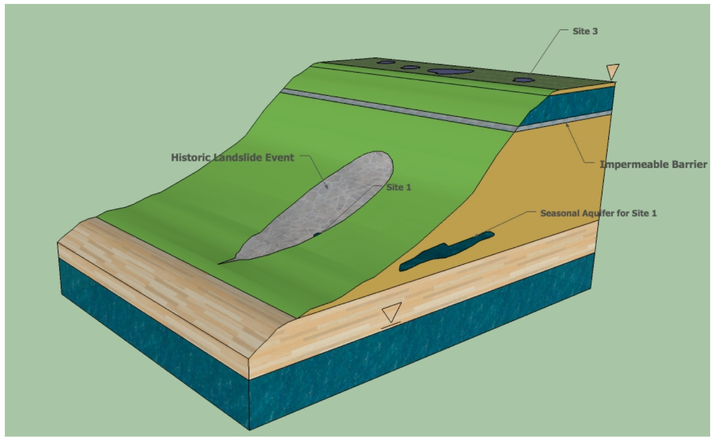
Oregon and the North Santiam River Basin

0 650 1,300 2,600 Ft

Project Springs
Contributing Area
Contour: 10 ft
North Santiam River

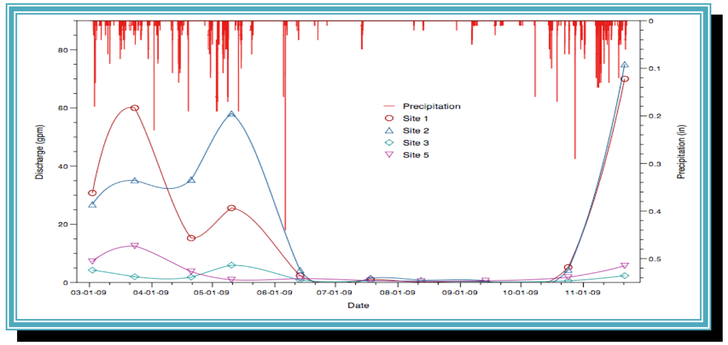
Mill City Microscale Hydropower Feasibility Study Site: 3/09-2/10

The obvious first step is mapping of the spring(s) at the site. This work was completed during the fall and spring months to ensure all of the springs were located, as well as to set up gauging stations to monitor flow.

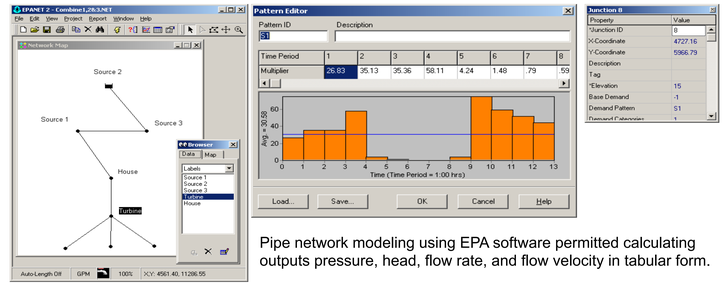


The second was to develop a conceptual model of the spring system. Are the springs derived from an area of limited storage, or are they derived from aquifers with extensive storage?

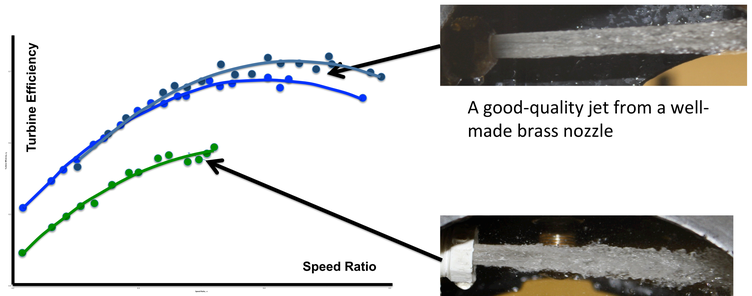
Research on Site Evaluation and Equipment Installation



How did springs respond to precipitation? There was a strong correlation to spring flow and precipitation, and along with isotopic analysis of the spring water, the springs drain an aquifer with limited storage.



Pipe network modeling using EPA software permitted calculating outputs pressure, head, flow rate, and flow velocity in tabular form.



Turbine efficiency vs. speed ratio for a 100-mm Pelton turbine with brass and plastic nozzles

A good-quality jet from a well-made brass nozzle

A poor-quality jet from a homemade plastic nozzle

Conclusions

Microscale hydroelectric power projects have vast potential to provide green energy to remote areas worldwide. The two most reliable tools used to characterize a micro hydroelectric power resource are a water balance and a geologic analysis. The other common tools of hydrologic analysis used in this research, temperature and stable isotope geochemistry, are not recommend for this scale of analysis.

Legal, regulatory and policy reform needs to occur. The public is receiving an inconsistent message when one branch of the government endorses this technology while another branch continues to place an unreasonable burden on the process.

Similar to microscale hydroelectricity itself, small reforms to improve efficiency in these systems will make a difference. With hundreds of thousands of potential sites all across the world, individual reforms are sure to amass into large scale systematic improvements in efficiency. This case study can help catalyze these opportunities both in Oregon and beyond.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	0	0	0	2
Masters	7	0	0	0	7
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	10	0	0	0	10

Notable Awards and Achievements

50th Anniversary of Water Resources Research at Oregon State University. Documentary video of interviews with past directors on YouTube http://www.youtube.com/watch?v=j9vZEn43RuE IWW Interim Director Todd Jarvis was appointed to the **Oregon State Board of Geologists Examiners (OSBGE) for a three year term by Governor Kitzhaber**. He replaces WRGP-affiliated faculty member Dr. Steve Taylor of Western Oregon University who served multiple terms under Governor Kulongoski, including most recently as the Chair of OSBGE . Todd served in a similar capacity for the Wyoming Board of Professional Geologists in the late 1990s under former Governor Geringer.

IWW awarded funding for International Projects Leader Richard Meganck to continue work for the International Center for Integrated Water Resources Management (ICIWaRM), a UNESCO Category 2 water center headquartered at the U.S. Army Engineer Institute for Water Resources (IWR). **Dr. Meganck is appointed as a member of the U.S. National Commission to UNESCO by Secretary Clinton.**

Sarah Sheldrick video **"Water Before Anything" funded by IWW through a USGS mini-grant awarded National Institutes for Water Resources first annual Pacific Northwest Regional IMPACT award.** Video now uploaded to UNESCO's Water Channel and has over 6,600 views Sarah is teaching a class on documentary film making in water resources through the Water Resources Graduate Program - (http://www.thewaterchannel.tv/index.php?option=com_hwdvideoshare&task=viewvideo&Itemid=4&video_id=1072)

Three graduate students and one undergraduate student invited to attend Third Annual symposium sponsored by the Universities Consortium on Columbia River Governance in Kimberley, British Columbia during October, 2011. **A poster prepared for conference titled "Capitalizing on Uncertainty: Development of Alternatives for Regional Dialogues of the Columbia River Treaty" wins American Water Resources Association – Oregon Section student poster award.** Student documentary video "A River Loved: A film about the Columbia River & the people invested in its future" debuts - http://www.youtube.com/watch?v=ZTIj8zIugdA Faculty from Oregon State University, the University of Oregon and Portland State University complete first year of work on a five-year project funded by the National Science Foundation titled **"Willamette Water 2100,"** a study that will use Oregon's Willamette River basin as a test case for managing regional water supply. This project is evaluating how climate change, population growth, and economic growth will alter the availability and the use of water in the Willamette River Basin on a decadal to centennial timescale.

IWW Collaboratory use numbers keep climbing from a sample count of 2,250 in 2008 to 10,325 in 2011. Number of users (departments, entities) doubles from 10 to 25 over same period.

IWW selected to assist the City of Corvallis with a pilot program on a first of its kind subsurface treatment of the thermal properties of the municipal wastewater through hyporheic exchange in a pioneering project in the Willamette River Basin.

Peggy Lee, a PhD candidate in the Water Resources Graduate Program selected for the East Asia Pacific Summer Institute for U.S. Graduate Students. Selection based in part on geospatial analysis work on the Metolius River in central Oregon through IWW and the Friends of the Metolius. The Metolius River is a unique natural resource in Oregon having been designated as the first Area of Critical Concern (AOCC) recognized under Oregon's legendary land use laws.

IWW and other Scholars who have shared information and datasets related to water resources research:

IWW Interim Director Todd Jarvis was invited to **Amman, Jordan by UNESCO PCCP for "Train the Trainer" Water Conflict Management Training for Arab Countries Water Managers,** Amman, Jordan, to teach 15 engineers and hydrologists from Iraq, Jordan, and the Palestinian Territories how to use the UNESCO handbook on Shared Waters and water conflict resolution.

Green building designer and contractor Garrett Moon of "The Commons" presents his work on becoming the first U.S. home to meet the Living Building Challenge to 300 students enrolled in GEO 300 Sustainability for the Common Good taught by IWW Interim Director Todd Jarvis - http://rainbowwatercoalition.blogspot.com/2011/10/osu-gets-mooned.html .

IWW sponsors National Ground Water Association Darcy Lecturer Stephen Silliman for Brown-bag luncheon lecture on "Characterization of a Complex, Sole-Source Aquifer System in Benin, West Africa".

IWW co-sponsors Climate Change Seminar Series: Can We Geoengineer Our Way Out of Climate Trouble?

- Experiments in Geoengineering: Controlling the Weather in 20th Century America, Dr. Kristine Harper
- Climate Geoengineering Governance, Dr. Steve Rayner
- Ocean Fertilization, Prof. Richard Lampitt

IWW co-sponsors conference on Exempt Wells, Problems & Approaches in the Northwest with the Colorado, Idaho, Montana, and Washington Water Resources Research Institutes in Walla Walla, Washington. Over 70 attendees from across the United States and Canada - http://cm.wsu.edu/ehome/index.php?eventid=24592& Theme issue on topic to be published in the Journal of Contemporary Water Research and Education.

IWW interim Director Todd Jarvis co-facilitates several Collaborative Learning Workshops and with Dr. Gregg Walker for the Partnership for Coastal Watersheds, Coos Bay, OR, Monthly Meetings from January – June, 2011.

IWW Interim Director Todd Jarvis presents workshop on Situation Mapping at the Association of Conflict Resolution conference held in Portland, OR.

IWW Interim Director Todd Jarvis presents a paper on Exempt Wells at the annual UCOWR-NIWR conference in Boulder, CO. IWW Interim Director Todd Jarvis was invited to present "Finding Water the ol' Timey Way: The History, Geography and Science of Water Witching" at the 2011 AWWA Oregon Subsection Water Works School at Clackamas Community College. Presentation was well attended by 139 water professionals.

Thirty fifth grade students at the Ashbrook Independent School in Corvallis invited Interim Director Todd Jarvis to present "Bottled Water and the Environment" along with a taste test between tap water and locally-bottled waters.

Oregon BEST-FEST, an annual gathering of professionals working in the **Built Environment & Sustainable Technologies Center,** invited Interim Director Todd Jarvis to present "Aquifer Storage, Transfer and Recovery of Urban Stormwater" and a poster "Going Green One Little Baby Step at a Time: Transforming Modern Power Production through Microscale Hydropower".

Interim Director Todd Jarvis invited to participate in the first Mountain West Waters Institute coordinated by Idaho National Laboratory to present "She Flies With Her Own Wings:The Oregon Water Center Story" in Salt Lake City, Utah.

2012 Publications

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